B.Tech. II (CSE) Semester – III (EC209)

DIGITAL COMMUNICATION (CORE-4)

(Interdisciplinary Subject)

Subject Coordinator : Prof. N. B. KANIRKAR, ECED.

	L	T	P	Credit
Scheme	**3**	**0**	**2**	**04**

Marks 100 + **50 = Total 150**

- INTERNAL EVALUATION QUIZ = 20 MARKS
- MID SEM EXAM = 30 MARKS
- END SEM EXAM = 50 MARKS

- **INTRODUCTION** **(05 Hours)**

History, Concept of Transmitter, Receiver, Channel, Noise, Modulation, Types of Modulation, Different communication systems based on Input and Output. Classification Of Signals, Unit Impulse Signals, Correlation Of Signals, Orthogonal Signal Set, Exponential Fourier Series, Types of Noises, Internal: Shot, Thermal, Agitation, Transit Time Noise and External: Atmospheric, Extra-Terrestrial, Industrial Noise, White Noise and Filtered Noise, AWGN Properties, Signal To Noise Ratio.

- **AMPLITUDE MODULATION (AM)** **(06 Hours)**

  AM, AM Index, Frequency spectrum, Average Power for Sinusoidal AM, Effective Voltage and Current, Non sinusoidal Modulation, DSBFC & DSBSC Modulation, Amplitude modulator and Demodulator Circuits, AM Transmitters.

- **SINGLE-SIDEBAND (SSB) MODULATION** **(06 Hours)**

  SSB Principles, Balanced Modulators, SSB Generation and Reception.

- **ANGLE MODULATION** **(06 Hours)**

Frequency Modulation (FM), Frequency spectra, Average power, Deviation Ratio, Measurement of Modulation Index, Phase Modulations (PM), Sinusoidal PM, Digital PM, Angle Modulator Circuits, FM Transmitters, Angle Modulations Detectors.

- **PULSE MODULATION** **(07 Hours)**

Pulse Amplitude Modulation, Pulse Code Modulation, Delta Modulation, Pulse Frequency Modulation, Pulse Time Modulation, Pulse Position modulation and Pulse Width Modulation.

- **DIGITAL CARRIER SYSTEM** **(06 Hours)**

Introduction and representation of Digital Modulated Signal, ASK, PSK, FSK, QAM with Mathematics and Constellation Diagram, Spectral Characteristics of Digitally Modulated Signals. M-Ary Digital Carrier Modulation.

- **FIBER-OPTIC COMMUNICATIONS** **(06 Hours)**

  Principles of Light Transmission in Fiber Losses in Fibers, Dispersion, Light Sources and Detectors for Fiber Optics.

4. Books Recommended:

1. Dennis Roddy & John Coolen, “Electronic Communications”, PHI, 4/E, 2014 Print.
2. George Kennedy, “Electronic Communication Systems”, 3/E, McGraw Hill Book Co., 1993.
3. Simon Haykin, “Communication Systems”, 2/E, Wiley Eastern Ltd, 1994.
4. Taub and Schilling, “Principles of communication Systems”, 3/E, Mc Graw Hill Publication, 1992.
5. B.P.Lathi, ”Modern digital and analog communication systems”, 4th Ed., Holt, Sounders Pub. 1998.

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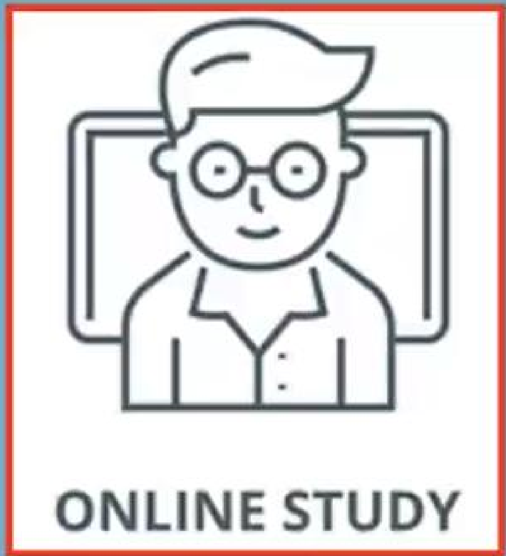
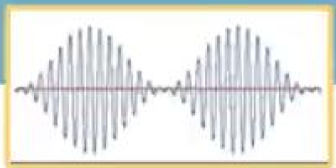
ADDITIONAL REFERENCE BOOKS

1. Lathi B. P. and Ding Zhi, "Modern Digital and Analog Communication Systems", Oxford University Press, 4th Ed., 2010.
2. Proakis J. and Salehi M., "Fundamental Of Communication Systems", PHI/Pearson Education-LPE, 2nd Ed., 2006.





LET US START ONLINE STUDY.......

Prof. N. B. Kanirkar
Associate Professor,
ECED, SVNIT.

DIGITAL COMMUNICATION

Prof. N. B. Kanirkar
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DIGITAL COMMUNICATION

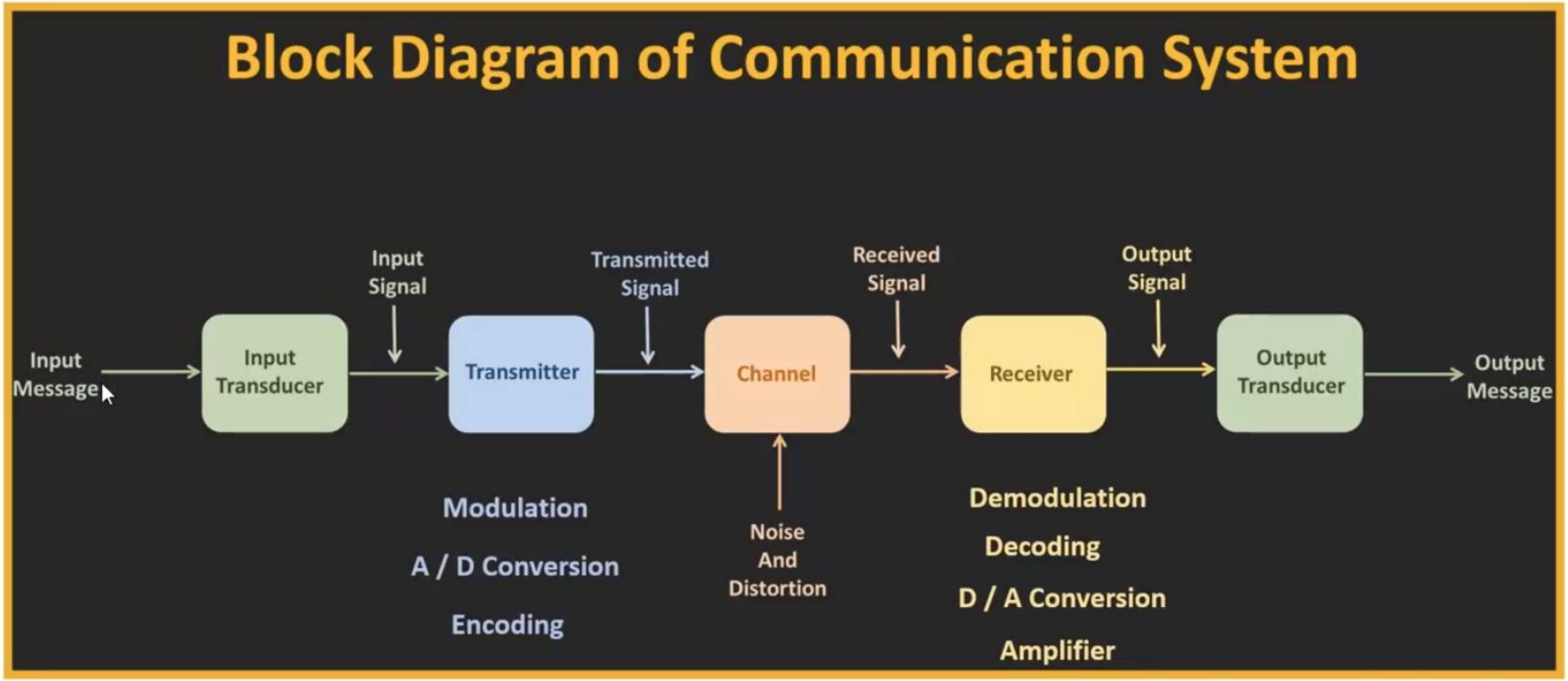
- Prof. N. B. Kanirkar

Good Morning

- Classification of Signals

Analog and Digital Communication

Types of Signals


Block Diagram of Communication System
Input Message
Input Transducer
Input Signal
Transmitter
Transmitted Signal
Channel
Received Signal
Receiver
Output Signal
Output Transducer
Output Message
Modulation
A / D Conversion
Encoding
Noise And Distortion
Demodulation
Decoding
D / A Conversion
Amplifier

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)

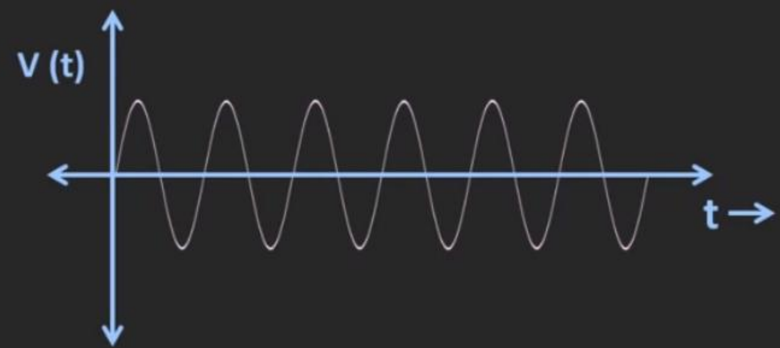
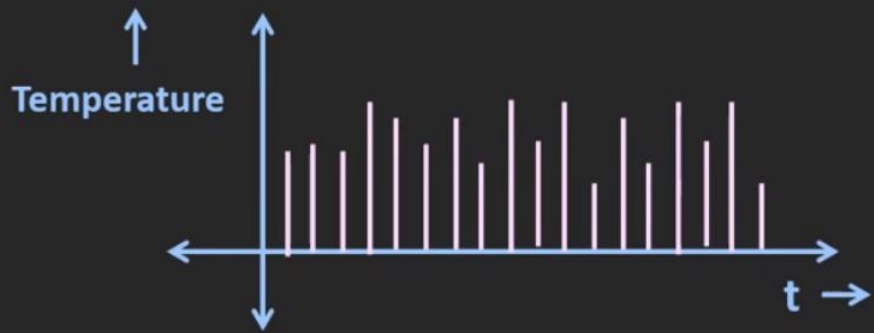


Fig. 1 (b)

Classification of Signal

Discrete time Signal

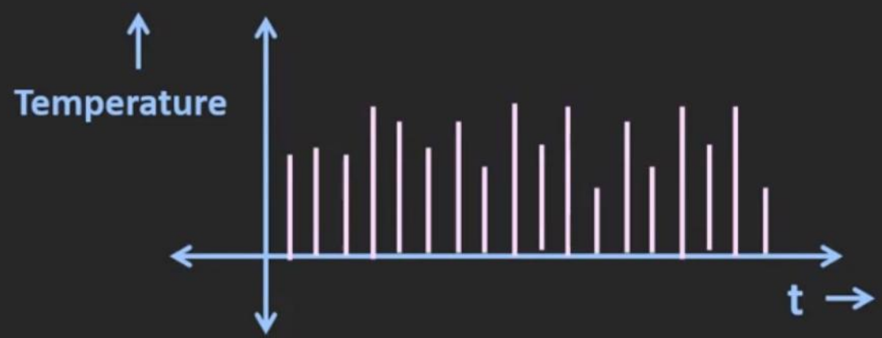
If the signal is specified only for discrete time instances then it is called Discrete time signal.



Classification of Signal

Analog Signal

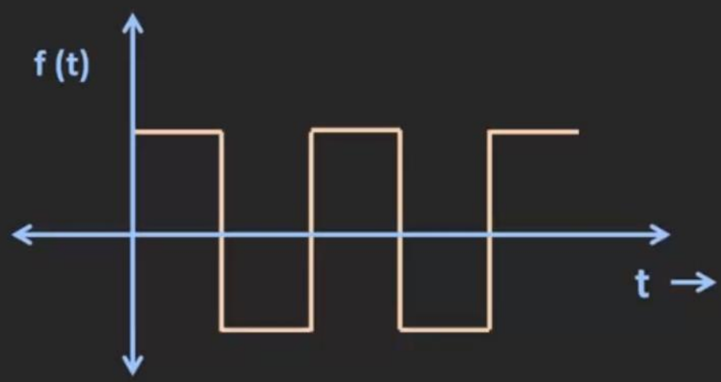
A signal whose amplitude can take any value in the continuous range is the analog signal.



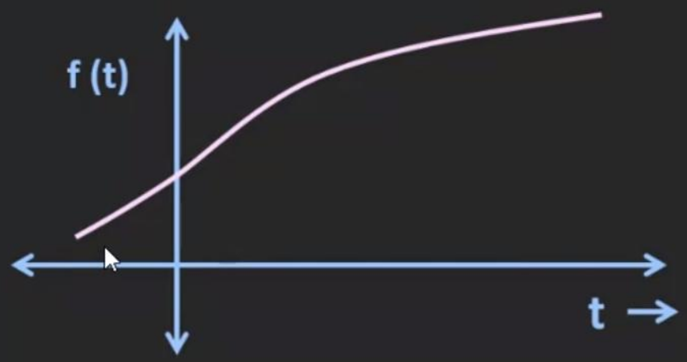
Classification of Signal

Digital Signal

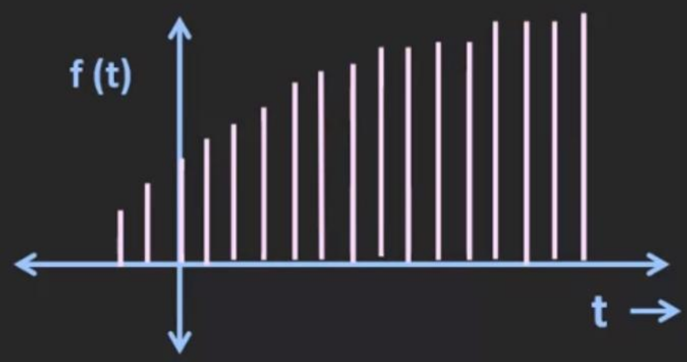
A signal whose amplitude can take only finite number of values is the digital signal.



Classification of Signal

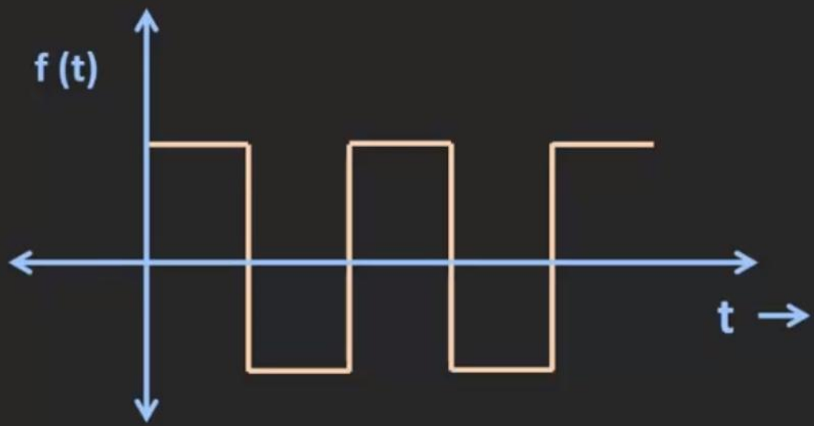


Analog and Continuous time signal

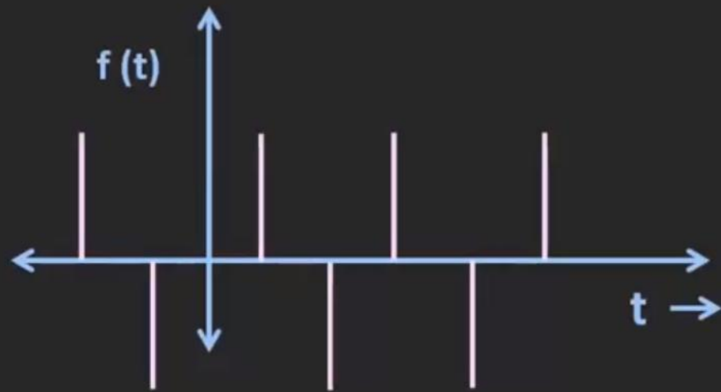


Analog and Discrete time signal

Classification of Signal



Digital and Continuous time signal

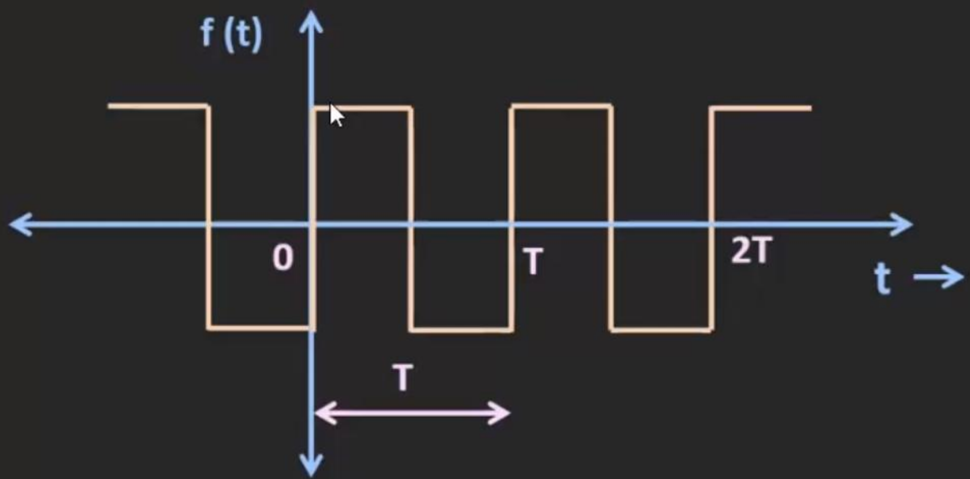


Digital and Discrete time signal

Classification of Signal

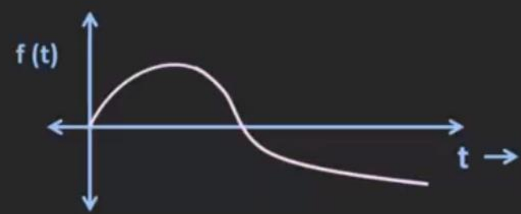
Periodic Signal

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

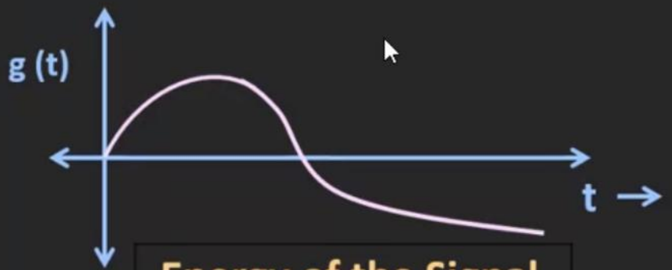


$$f(t) = f(t + T)$$

Aperiodic Signal



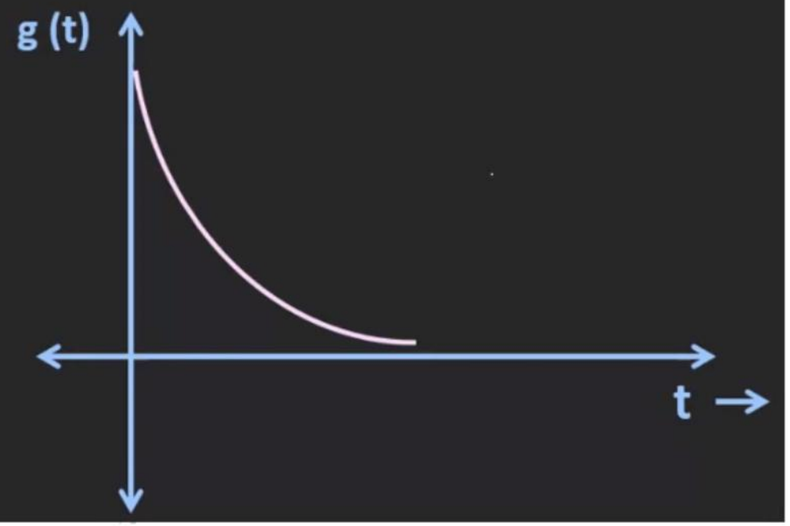
Strength of the Signal



Energy of the Signal

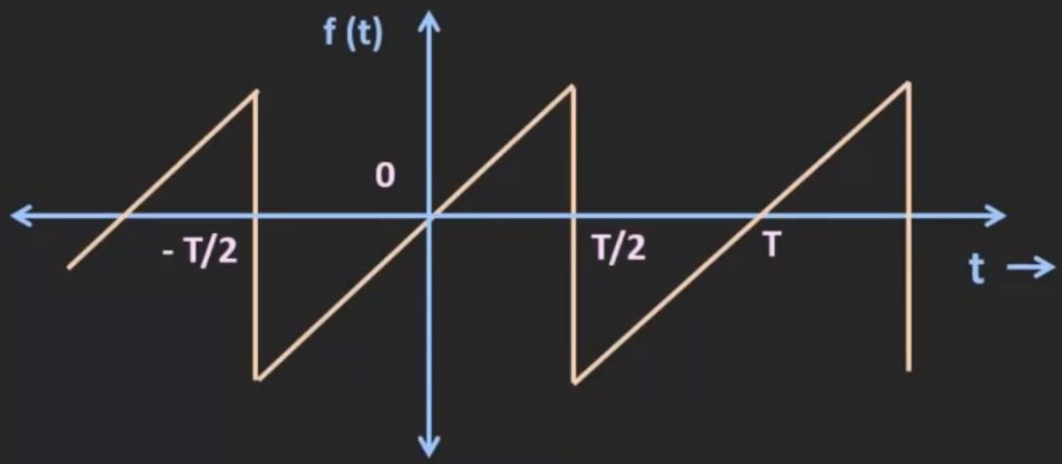
$$E_g = \int_{-\infty}^{\infty} g^2(t)\,dt$$

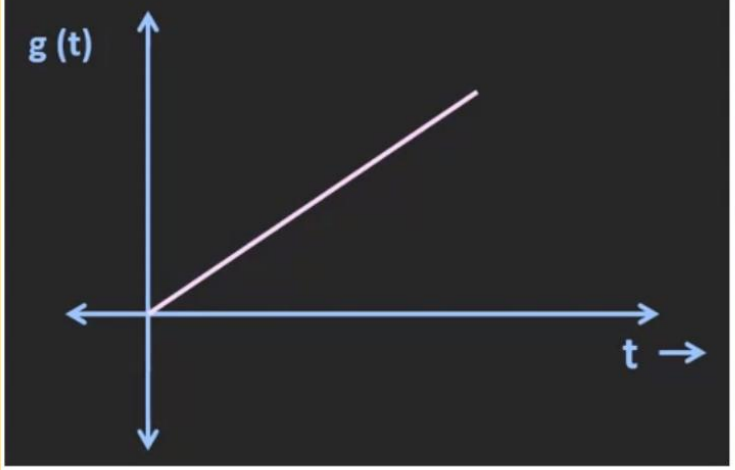
Strength of the Signal



Average Power of the Signal

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





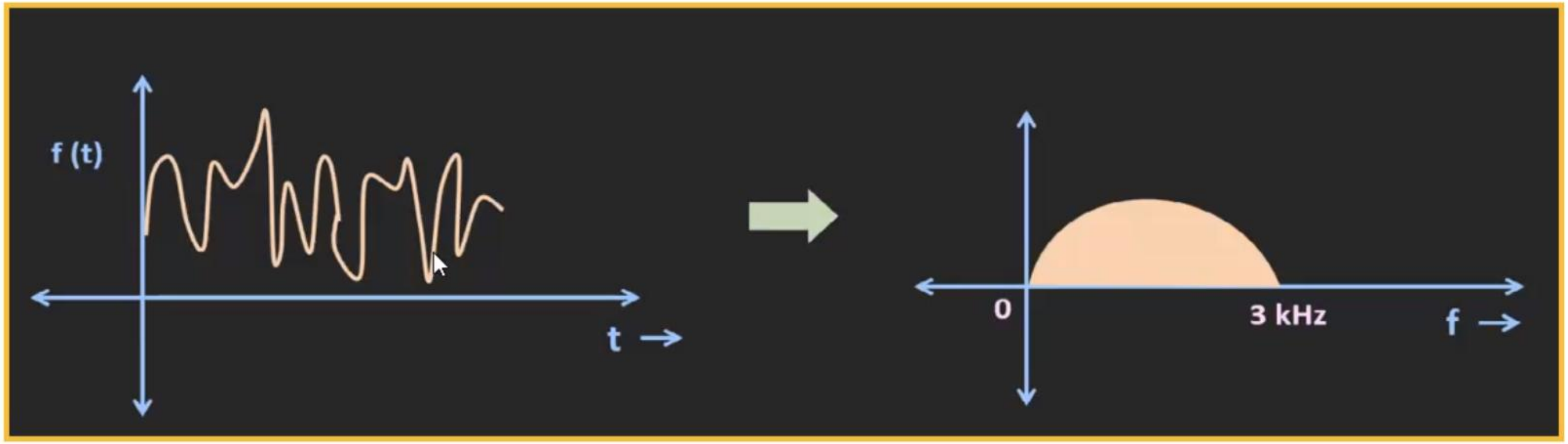
Classification of Signal

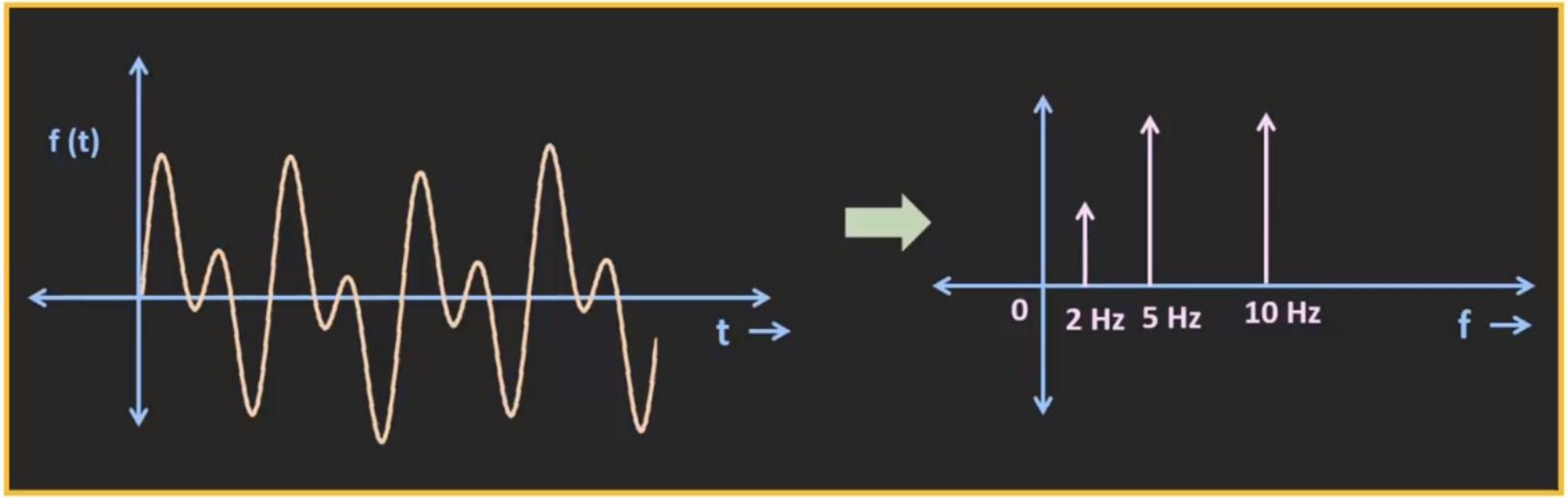
Deterministic Signal

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.


f (t)
t →
0
3 kHz
f →


f (t)
t →
0
2 Hz
5 Hz
10 Hz
f →

Fourier Series

Fourier Series

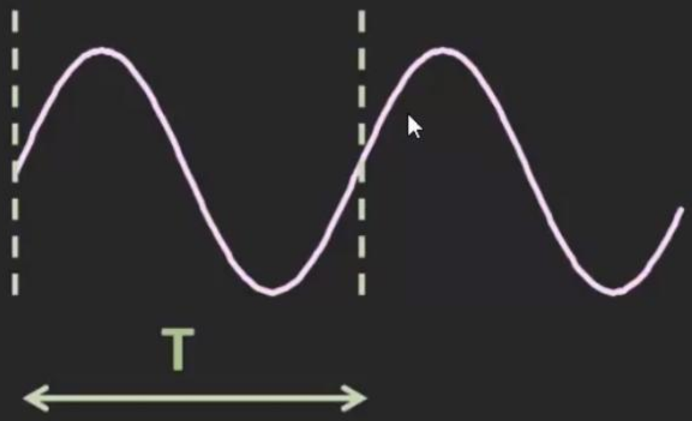
Any periodic signal can be represented by the linear combination of sine and cosines which are harmonically related to each other

Continuous Time Fourier Series (CTFS)

Discrete Time Fourier Series (DTFS)

Harmonics

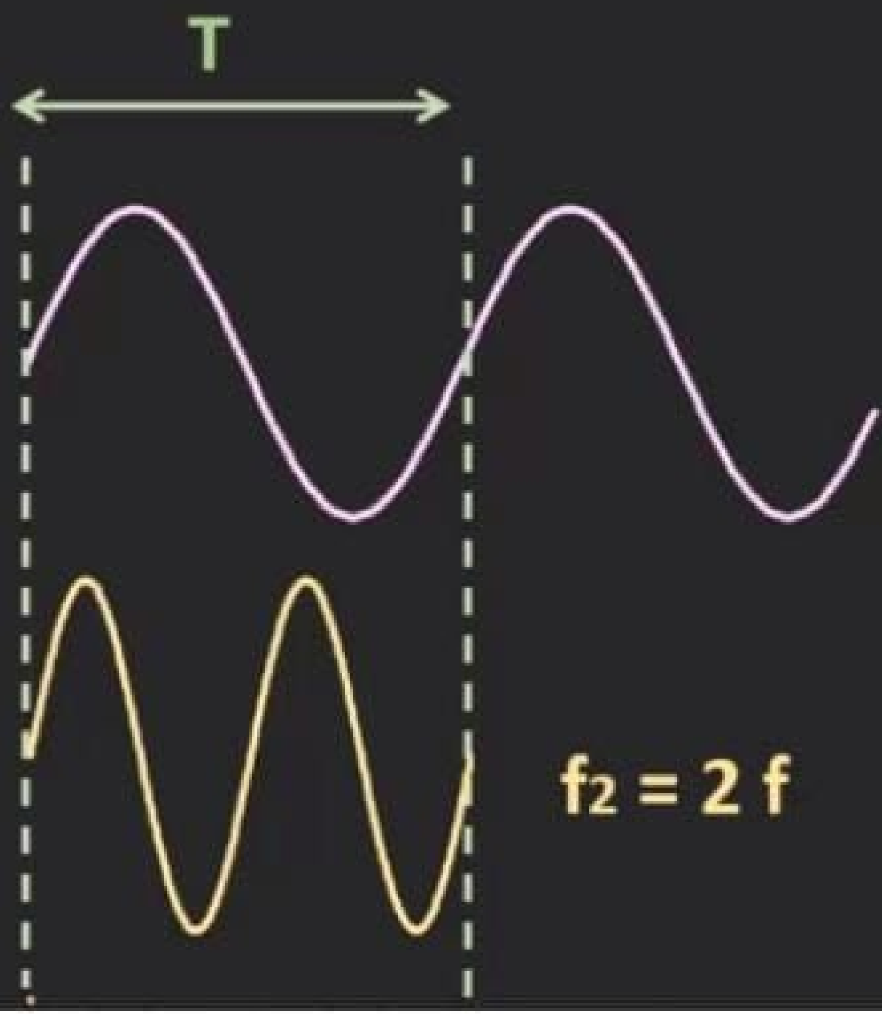
Integer Multiple of the fundamental Frequency



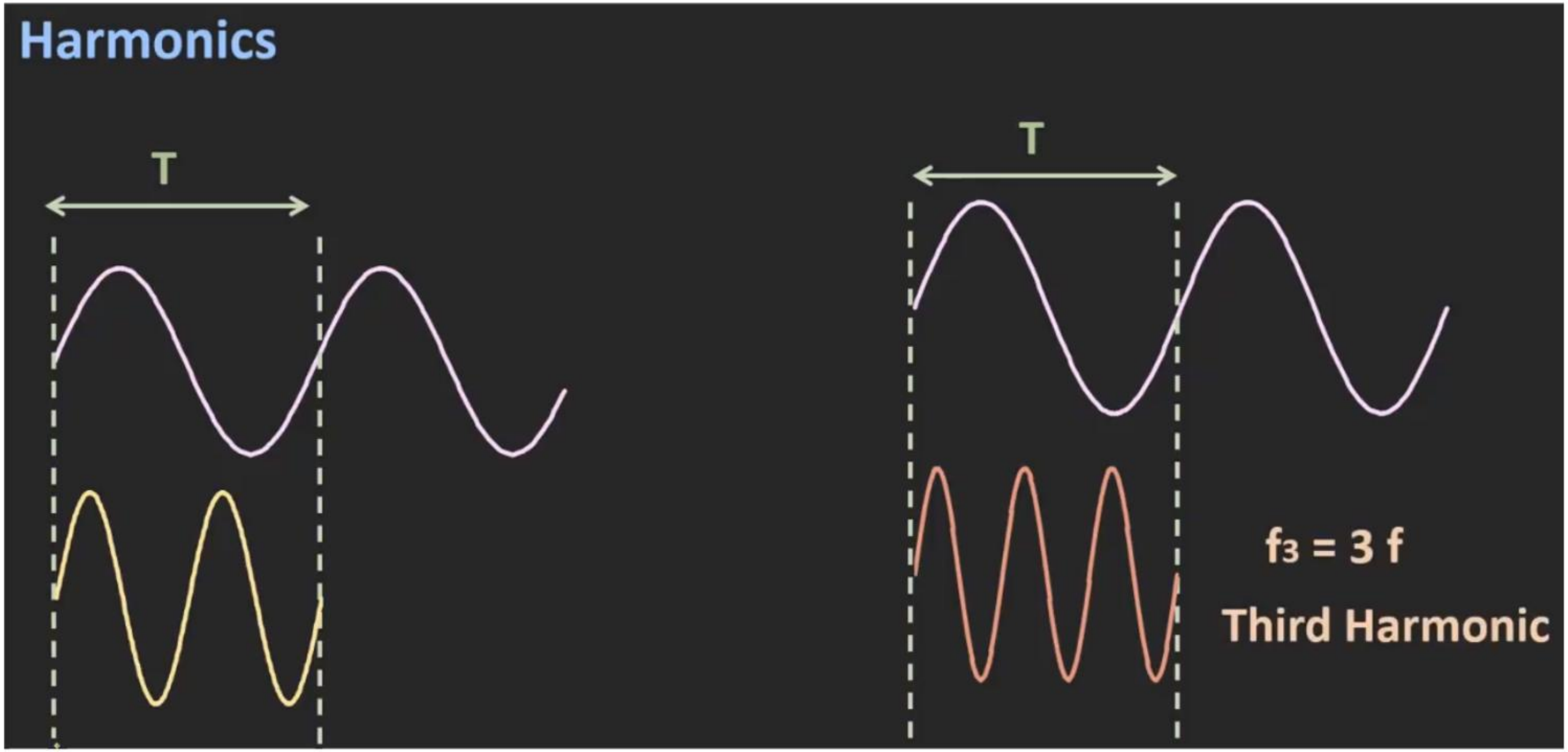
$$f = \frac{1}{T}$$

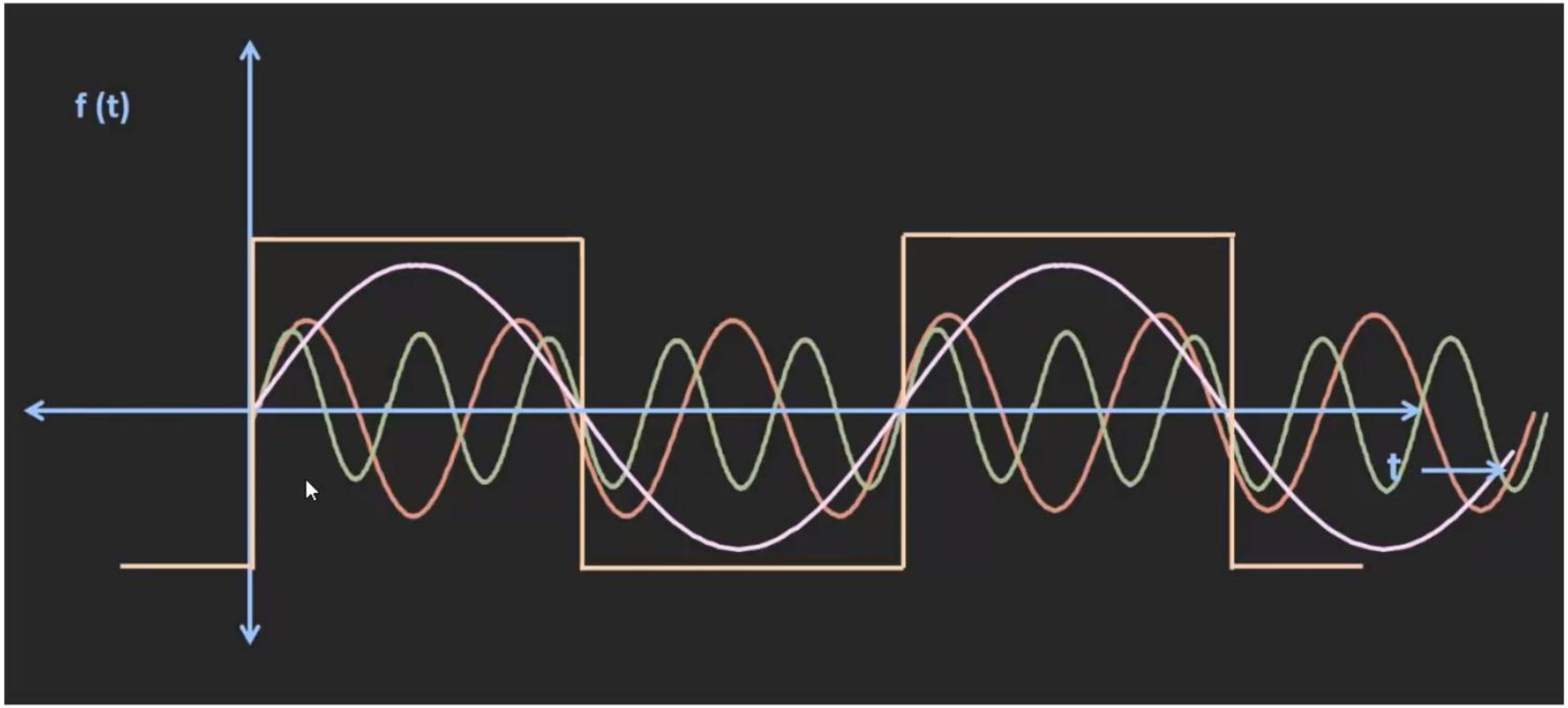
f – Fundamental Frequency

Harmonics



$f_2 = 2f$ 2 f – Second Harmonic


Harmonics
T
T
f3 = 3 f
Third Harmonic

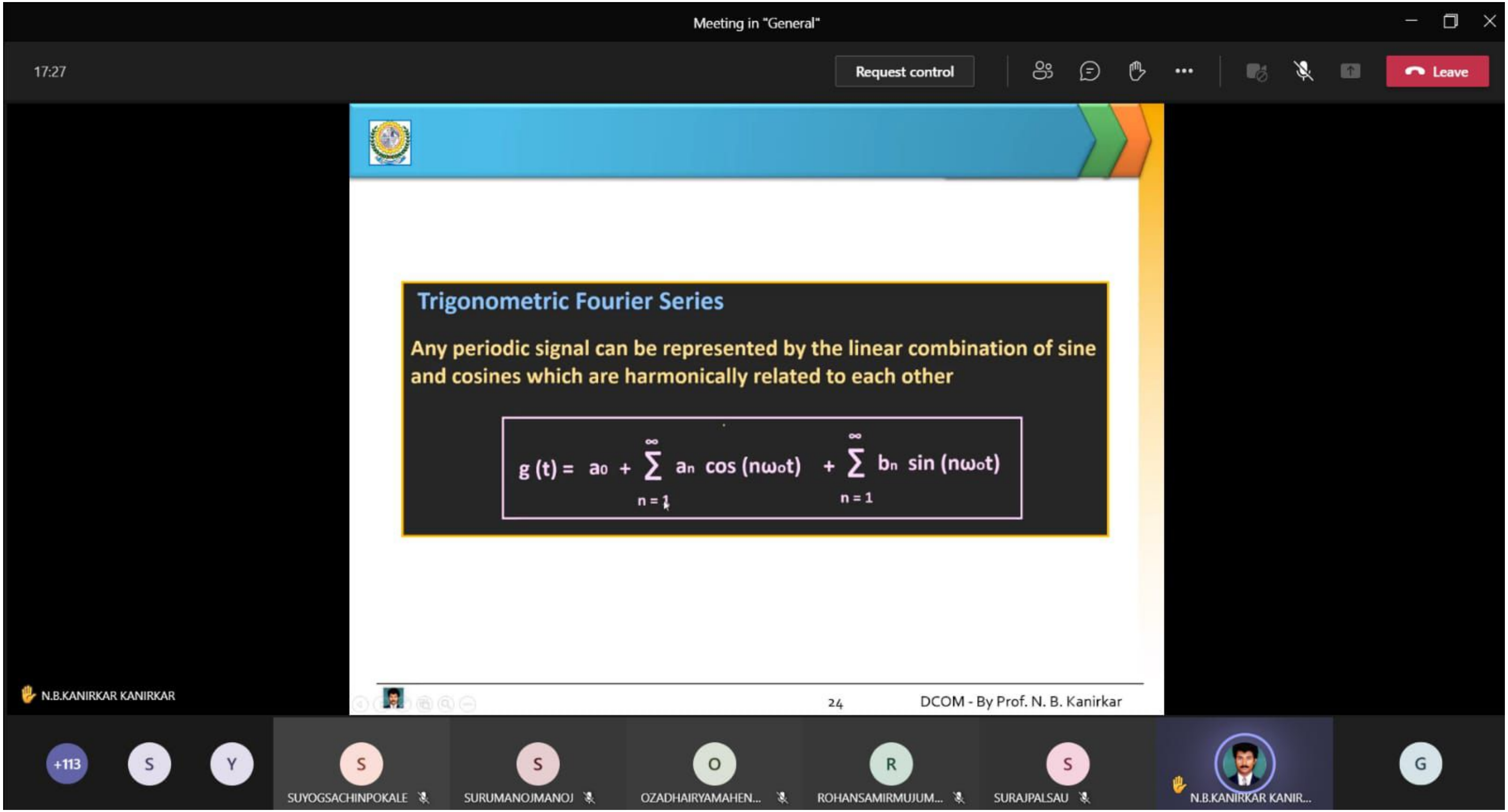

f (t)
t

Fourier Series

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

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

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


Meeting in "General"
17:27
Request control
Leave
Trigonometric Fourier Series
Any periodic signal can be represented by the linear combination of sine and cosines which are harmonically related to each other
$$g(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos(n\omega_0 t) + \sum_{n=1}^{\infty} b_n \sin(n\omega_0 t)$$
24
DCOM - By Prof. N. B. Kanirkar
N.B.KANIRKAR KANIRKAR
+113
SUYOGSACHINPOKALE
SURUMANOJMANOJ
OZADHAIRYAMAHEN...
ROHANSAMIRMUJUM...
SURAJPALSAU
N.B.KANIRKAR KANIR...

$$a_0 = \frac{1}{T} \int_{To} g(t)dt$$

$$a_n = \frac{2}{T} \int_{To} g(t) \cos (n\omega_o t)dt$$

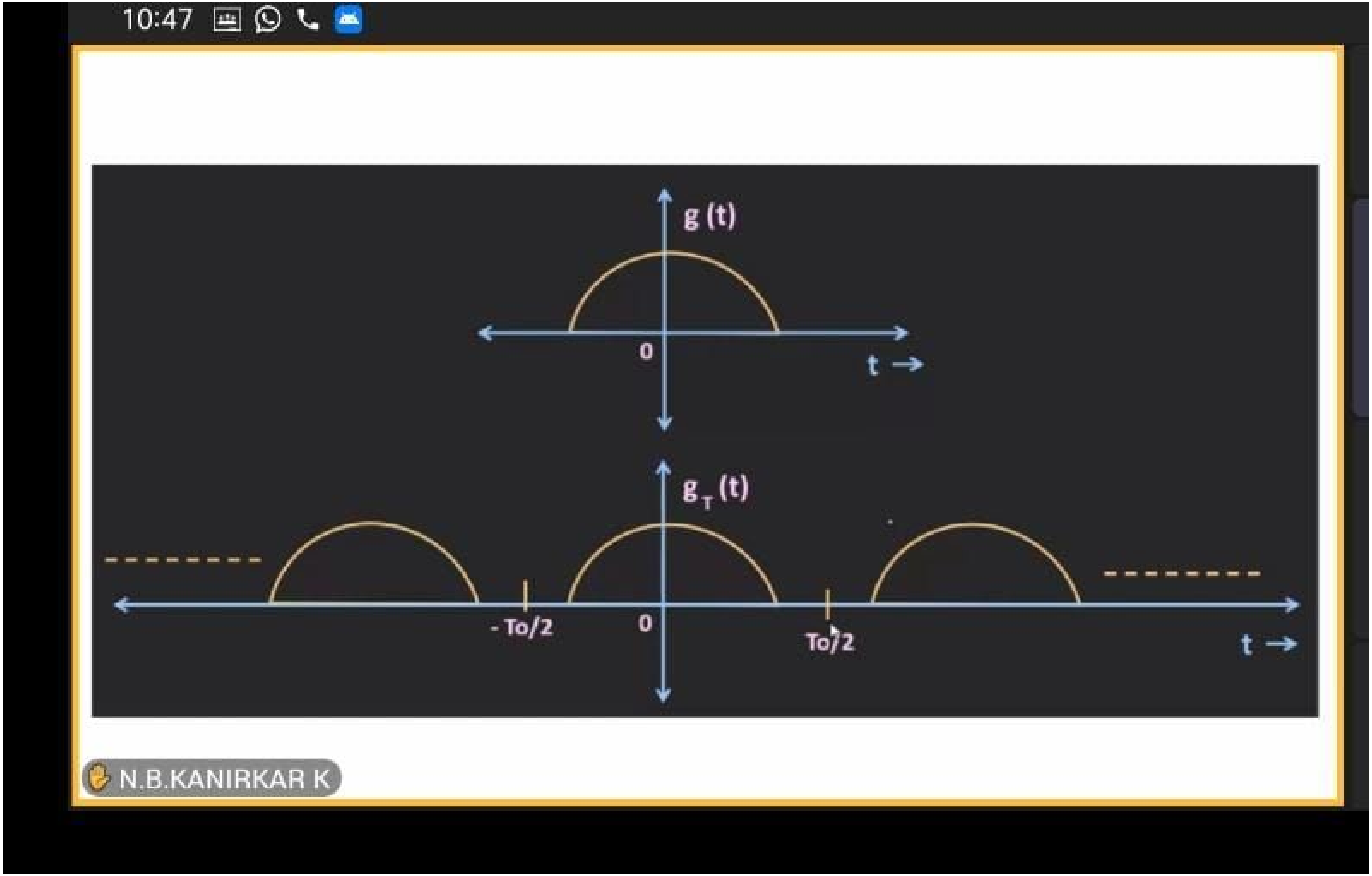
$$b_n = \frac{2}{T} \int_{To} g(t) \sin (n\omega_o t)dt$$

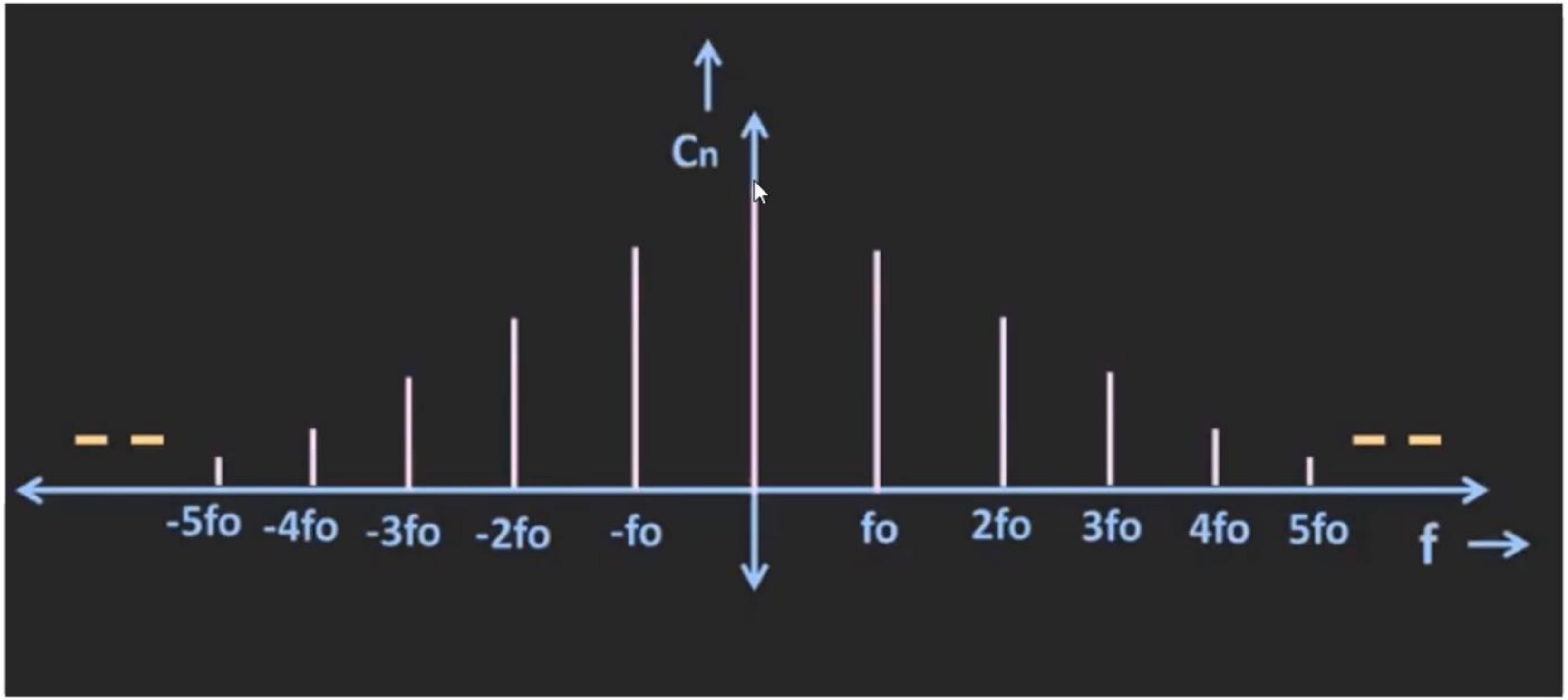
Exponential Fourier Series

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

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

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


10:47
g (t)
0
t →
g_T (t)
- To/2
0
To/2
t →
N.B.KANIRKAR K



Cn
-5fo
-4fo
-3fo
-2fo
-fo
fo
2fo
3fo
4fo
5fo
f

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

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

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

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

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

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

$$\int_{t1}^{t2} g(t)\, x^*(t)\, dt = 0 \quad \text{or} \quad \int_{t1}^{t2} g^*(t)\, x(t)\, dt = 0$$

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

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

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

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

$= 0$

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

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

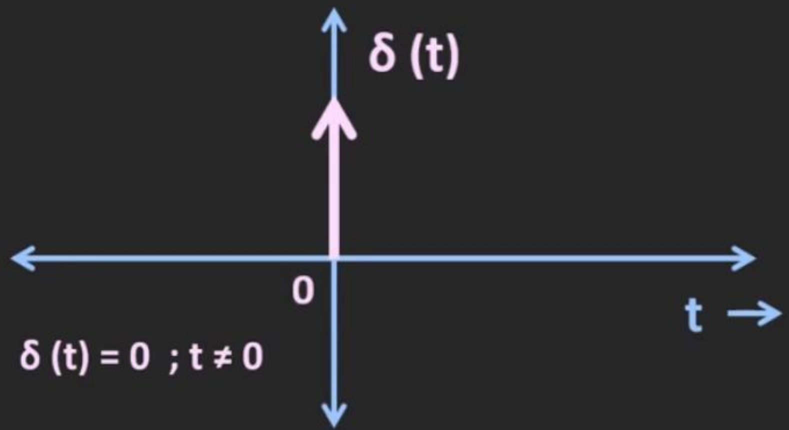
$$x_n(t) = e^{jn\omega_0 t}$$

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

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

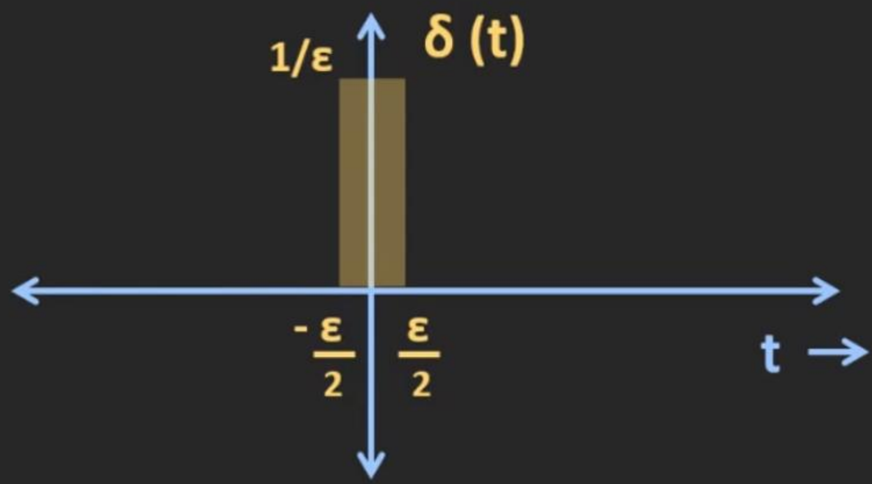
$$C_n = \frac{1}{T}\int_0^T g(t)\, e^{-jn\omega_0 t} \, dt$$

Unit Impulse Function



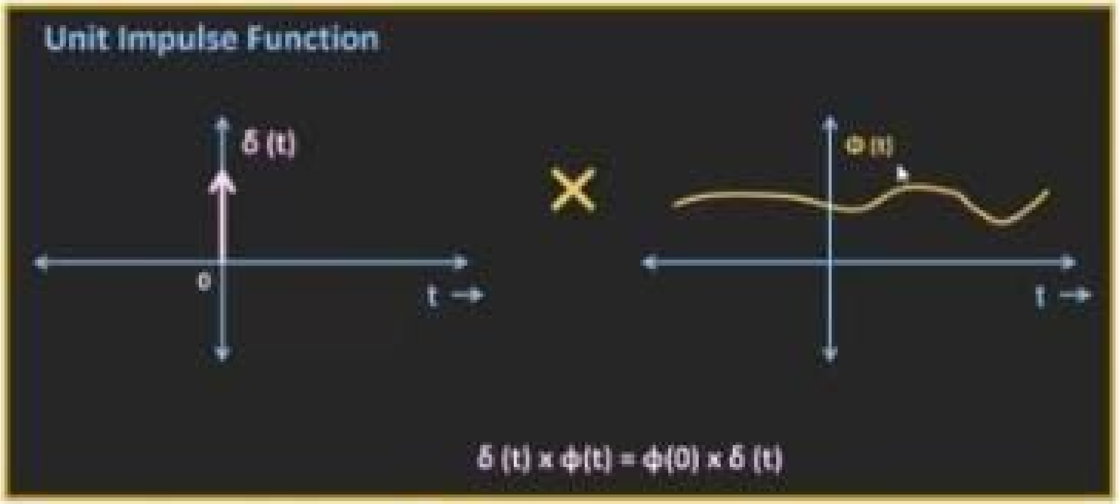
$\delta(t) = 0 \; ; \; t \neq 0$

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

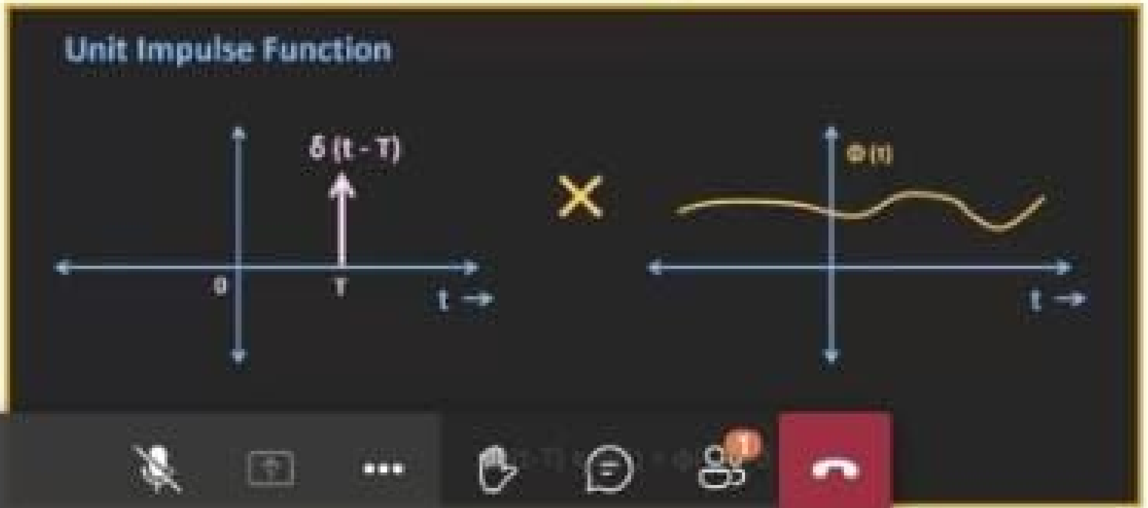


$\epsilon \rightarrow 0$

Search



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 →

36:12

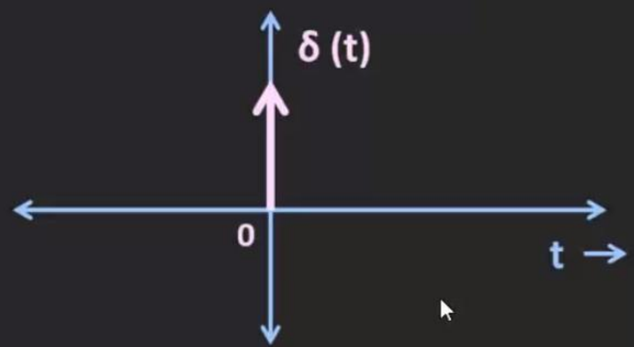
Unit Impulse Function

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

Unit Impulse Function

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

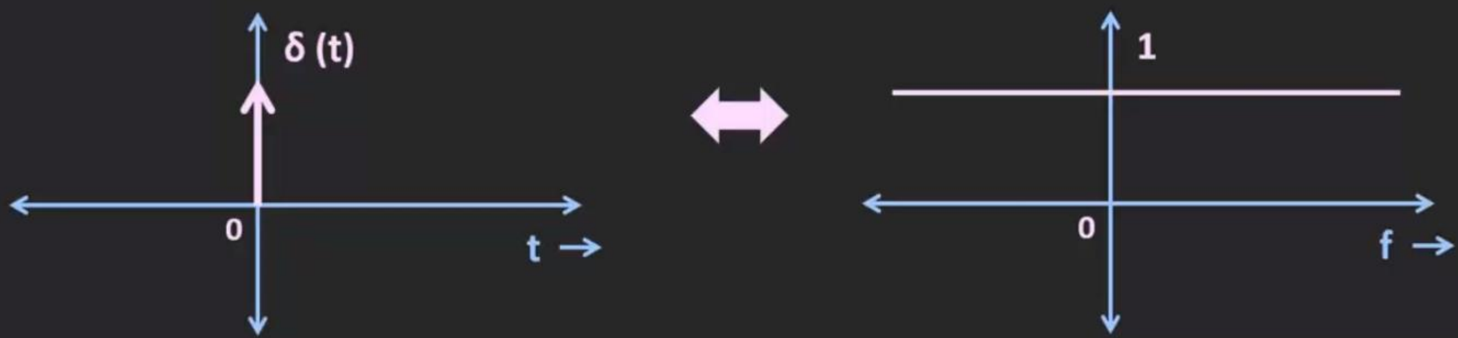
Unit Impulse Function



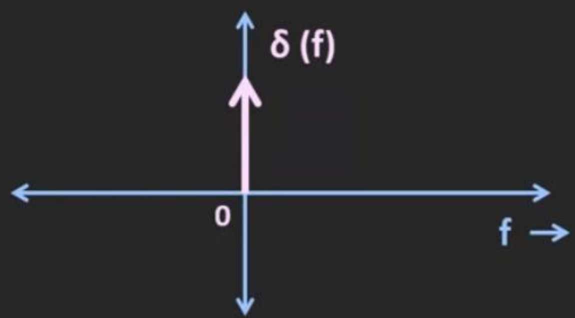
$$F[\delta(t)] = \int_{-\infty}^{\infty} \delta(t) \cdot e^{-j\omega t}\, dt$$

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

Unit Impulse Function



Unit Impulse Function



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

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

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

Unit Impulse Function