Syllabus

- Signals
- System
- Continuous Time Fourier Series (CTFS)
- Discrete Time Fourier Series (DTFS)
- Continuous Time Fourier Transform (CTFT)
- Discrete Time Fourier Transform (DTPT)

Syllabus

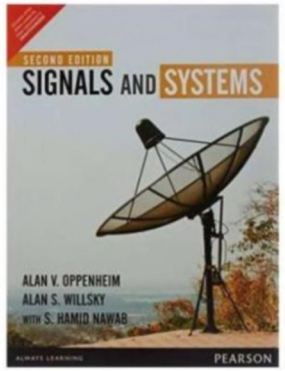
- Sampling
- Laplace Transform
- Z-Transform
- Discrete Fourier Transform
- Fast Fourier Transform
- Digital Filters

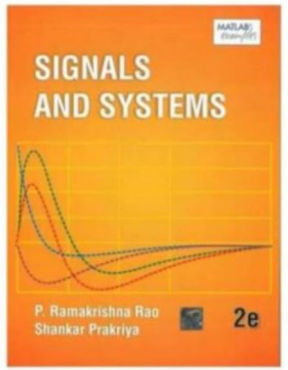
Weightage

- GATE : 6-8 marks
- ESE prelims : 20-30 Marks
- ESE mains : 40-50 Marks

Resources

1. Theory: class notes
2. Practice → class Q + assignment
   → PYQ (EE/EC/IN)
   → workbook signal
3. Quizzes & tests





Signals and Systems (Electrical Engineering)

Chapter	2018	2019	2020	2021	2022	2023	2024
C.T AND D.T SIGNALS ✓	2	1	1	2	0	2	2
LTI SYSTEM (C.T AND D.T) ✓	1	0	2	2	4	1	5
C.T PERIODIC SIGNAL : FOURIER SERIES	0	2	0	0	2	2	0
C.T SIGNAL : FOURIER TRANSFORM ✓	0	0	0	4	2	3	1
SAMPLING THEOREM	2	0	0	0	0	0	0
C.T SIGNAL : LAPLACE TRANSFORM	0	3	4	0	0	0	1
D.T SIGNAL : Z TRANSFORM ✓	0	0	3	2	0	1	2
TOTAL	5	6	10	10	8	8	11

Signals and Systems (Electronics Engineering)

Chapter	2018	2019	2020	2021	2022	2023	2024
BASIC OF SIGNAL AND SYSTEM	1	1	0	0	0	3	0
LTI SYSTEM (C.T AND D.T) ✓	0	0	1	2	3	2	1
FOURIER SERIES	1	0	0	2	0	0	0
FOURIER TRANSFORM ✓	2	0	2	0	1	1	2
LAPLACE TRANSFORM	0	1	2	0	0	1	0
Z TRANSFORM ✓	1	1	3	0	0	0	1
SAMPLING THEOREM	2	0	0	1	0	0	0
DTFS, DTFT AND DFT ✓	2	4	2	3	2	4	2
TOTAL	9	7	10	8	6	11	6

Signals and Systems (Instrumentation Engineering)

Chapter	2018	2019	2020	2021	2022	2023	2024
BASIC OF SIGNAL AND SYSTEM ✓	2	1	1	1	1	2	0
LTI SYSTEM (C.T AND D.T)	0	0	0	1	0	2	1
FOURIER SERIES	0	0	2	0	1	0	0
FOURIER TRANSFORM ✓	2	2	1	0	0	2	0
LAPLACE TRANSFORM ✓	0	1	0	1	2	2	2
Z TRANSFORM ✓	2	0	0	2	2	2	2
SAMPLING THEOREM	0	0	0	2	0	0	1
DTFS, DTFT AND DFT ✓	2	2	2	0	2	0	2
DIGITAL FILTER	1	2	0	2	0	0	0
TOTAL	9	8	6	9	8	10	8

Gate 2024 Syllabus (Electrical Engineering)

Representation of continuous and discrete time signals, shifting and scaling properties, linear time invariant and causal systems, Fourier series representation of continuous and discrete time periodic signals, sampling theorem, Applications of Fourier Transform for continuous and discrete time signals, Laplace Transform and Z transform, R.M.S. value, average value calculation for any general periodic waveform. → 1st chapter

Gate 2024 Syllabus (Electronics Engineering)

Continuous-time signals: Fourier series and Fourier transform, sampling theorem and applications. CTFS CTFT

Discrete-time signals: DTFT, DFT, z-transform, discrete-time processing of continuous-time signals.

LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay

LT/ZT — fourier transform

Gate 2024 Syllabus (Instrumentation Engineering)

Periodic, aperiodic and impulse signals; Laplace, Fourier and z-transforms; transfer function, frequency response of first and second-order linear time-invariant systems; impulse response of systems; convolution, correlation. Discrete-time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters.

digital filters

What is a signal?

A signal is formally defined as a function of one or more variables that contains some information about certain physical phenomenon.

Independent variable: eg space, time etc

Dependent variable : eg electric field, magnetic field etc.

$$E = \frac{q}{4\pi\varepsilon r^2}$$

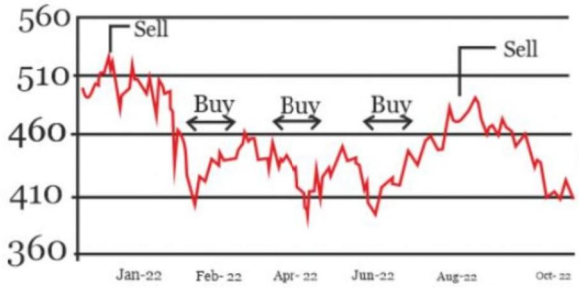
E: dependent; r: independent

as the value of indep. variable varies the dep. variable automatically varies.

Examples

Share price as a function of time.

All functions are not signal but all signals are functions



Examples

ECG Signals:

Heart rate monitoring

plotting heart rate as a function of time

Important Point

When signal is a function of only 1 variable it is said to be one-dimensional

When signal is a function of more than 1 variable then it is said to be multi-dimension

$y = z(t)$ → one dimensional

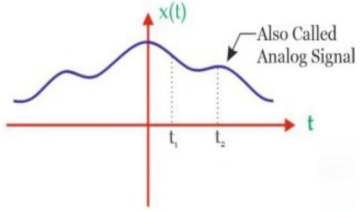
dependent, independent

$y = f(x, y, z)$ → multi-dimensional

Classification of Signals
(1) Continuous Time and Discrete Time Signal
Continuous Time Signal

A signal defined for all values of time is called as CT signal

If we choose any 2 time instant and the signal is defined ~~∀~~ t between t time instants, then it is called as CT signal)



Analog signals analogous to real world signals which are mostly continuous time.

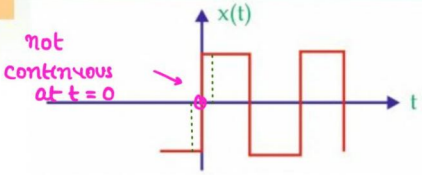
Such signals are obtained from physical phenomenon using transducers.

Important Point

Mathmatical notion of continuity

$$\lim_{t \to t_o} f(t) = \lim_{t \to t_o^+} f(t) = f(t_o)$$

$f(t)$ is continuous at $t = t_o$



A continuous time signal need not be continuous in mathematical sense

In mathematics, continuity is judged on the basis of variable on y-axis i.e., there must not be any sudden jumps in value of functions.

In case of signal, we are judging continuity of variable along x-axis.

Discrete Time Signal

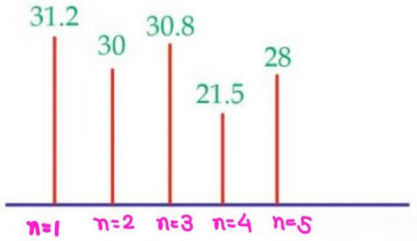
DT signals are those which are only defined at discrete instants of time.

Independent variable has discrete value usually uniformly spaced.

DT signals are derived from CT signals by a process called as sampling.

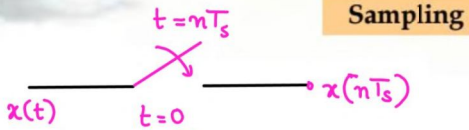
Example

Suppose we note down the temperature at a particular place at 5 am every time, we get a discrete time signal where n denotes the number of day.



Sampling

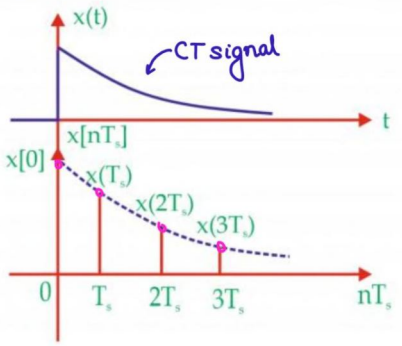
**SN



equally spaced samples → uniform sampling

T_s: sampling interval

$f_s = 1/T_s$: sampling freq.



- To obtain digital signal from discrete time signal we define discrete levels on y-axis & the signal value is approximated to nearest level.
- Continuous Time Signal
  - ↳ continuous in amp. (may not be true)
  - ↳ continuous in time
- Discrete time signal
  - ↳ continuous in amp
  - ↳ discrete in time
- Digital signal
  - ↳ discrete in amp.
  - ↳ discrete in time

→ Process of approximating signal value to nearest level is called Quantization & error introduced is called Quantization Error.

Representation of CT Signals

① equation as a function of time

$x(t) = 2e^{-2t}u(t)$

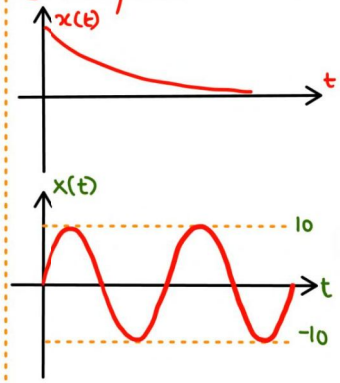
$x(t) = 10\sin(100\pi t)$

② look up table

$$x(t) = \begin{cases} 1, & 0 < t < T/2 \\ -1, & T/2 < t < T \end{cases}$$

tabular form, by knowing time we can know signal value from table.

③ waveform



**SN

Representation of DT Signals

- we generally represent DT signal as x[n]
  - ↳ represents n^{th} sample of sequence.

ⓐ mathematical equation

$x[n] = 2^{|n|}$

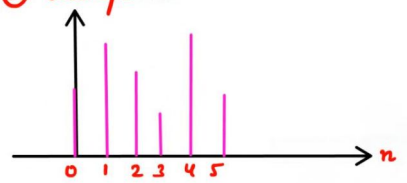
ⓑ look up table

$$x[n] = \begin{cases} 10, & -\infty < n < -5 \\ 5, & -5 \le n \le 5 \\ -5, & n > 5 \end{cases}$$

ⓒ recursive formula

$x[n] = 2x[n-1] + \delta[n]$

ⓓ waveform



$x[n] = \{2, 4, 8, 16 \dots\}$

$n = 0$

$n \in \mathbb{I}$

Question-1

Signal is a _____
(a) Time variant ← varies with time
(b) It is a physical phenomenon
(c) Conveys information
(d) All of the above

Question-2

_____ are the examples of signal
(a) Human voice
(b) Electrical signals
(c) Voltage on telephone wires
(d) All of the above

Question-3

In a _____ signal, we can define the value of the signal at any instant of time?
(a) Continuous
(b) Discrete
(c) Both a and b
(d) None of the above

Question-4

In a _____ signal, we can not define the value of the signal at any instant of time?
(a) Continuous
(b) Discrete
(c) Both a and b
(d) None of the above

Question-5

If a signal $x(t)$ does not have any definite values at certain points for certain values of 't' but has a definite value at the remaining points, then the signal is said to be a-

(a) Non-periodic signal
(b) Piecewise continuous signal ←
(c) Deterministic signal
(d) Random signal

pieces or portions of signal are continuous but complete signal is not continuous.
eg. square wave

Question-6

The time system which operates with a continuous time signal and produces a continuous time output signal is the

(a) CT system
(b) Lumped parameter system
(c) DT system
(d) Distributed parameter system

Question-7

X(t) =Sin(200πt). Calculate D.T.S if f_s=10Hz

$T_s = 1/f_s = 1/10$

Sampling: $t = nT_s = n/10$

$x[n] = \sin\left(200\pi \times n/10\right)$

$= \sin(20\pi n)$

$= 0$

Sine & cosine are 0 at multiples of π

Question-8

X(t) = $\frac{1}{2}e^{-0.5t}$. Calculate D.T.S if f_s=10Hz

$T_s = 1/f_s = 0.1$

Sampling: $t = nT_s$

$x[n] = \frac{1}{2}e^{-0.5(0.1n)}$

$= \frac{1}{2}e^{-0.05n}$

Answer Keys

1. D
2. D
3. A
4. B
5. B
6. A
7. Sin(20πn).
8. $\frac{1}{2}e^{-0.5n}$

Student's Assignment

Question-1

$X(t) = \begin{cases} 1-|t| & :\leq 4 \\ 0 & : else \end{cases}$. Calculate D.T.S if $t_s = 2sec$

Question-2

$X(t) = \begin{cases} 1-\left|\frac{t}{4}\right| & :\leq 4 \\ 0 & : else \end{cases}$. Calculate D.T.S if $f_s = 0.25Hz$

Question-3

The signal denoted by x(t) is known as
(a) Discrete time signal
(b) Continuous time signal
(c) Both (1) and (2)
(d) None of above

Question-4

Which of the following is not one of the representation of discrete-time signal?
(a) Sequence representation
(b) Graphical representation
(c) Analytical representation
(d) Tabular representation

Answer Keys

1. .
2. .
3. B
4. C

Operations on Dependent Variable

(1) Amplitude Scaling

SN

Also called as multiplication of a signal by a scalar

$Z(t) = ax(t)$

If $|a| > 1$, then it is amplification

If $|a| < 1$, then it is attenuation

Multiply all y-axis values by 'a' w/o modifying values along x-axis