

Meet - Communication System

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SANTI PRASAD MAITY is presenting

Pulse Analog Modulation

Santi P. Maity

BEIT 4th semester

1

25 others

You

43

The image shows a Google Meet session. The main screen displays a presentation slide with the title 'Pulse Analog Modulation' and the name 'Santi P. Maity'. Below the name is the text 'BEIT 4th semester'. On the right side, there is a grid of participant thumbnails, each with a name and a microphone icon. The participant at the top left of the grid is highlighted with a blue border and has a green circular icon with a white 'S' next to it. The names of the participants are partially visible, such as '2020ITB065 TATH...', '2020ITB077 RAHU...', '2020ITB029 JATIN...', '2020ITB097 JATIN...', '2020ITB081 ABHIJI...', '2020ITB044 NAMB...', '2020ITB064 VISHA...', '2020ITB099 SUBH...', '2020ITB019 MANA...', '2020ITB010 MADH...', and '25 others'. At the bottom of the screen, there is a toolbar with various icons for video, audio, and sharing.

Continuous and Discrete Time Signal

Sampling---A Continuous curve can be represented as discrete set of points

Continuous Time Signal
e.g. $x(t)=\sin(2\pi ft)$
Application:
Conventional telephone (PSTN), FM radio, TV Broadcast, etc.

Discrete Time Signal
e.g. $x(n)=\sin(2\pi fn)$
Application:
2D set of grids

The diagram illustrates the sampling process. On the left, a pink cloud contains information about continuous and discrete time signals. A large green arrow points from this cloud to a graph of a sine wave on a Cartesian coordinate system. The x-axis is labeled 'x' and has tick marks for π and 2π . The y-axis is labeled 'y' and has tick marks at -10, -5, 5, and 10. A second green arrow points from the graph to a green grid on the right. The grid is labeled 'X[n]' at the top center. It features vertical lines connecting black dots, representing the sampled values of the continuous signal at regular intervals.

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2020ITB066 GOLI_SREEJA
present sir
2020ITB055 DEBO...

Reconstruction of original signals

Frequency-Division Multiplexing (FDM)
(Examples: Radio-station signals and analog cell phones)

All the channels can share the same medium.

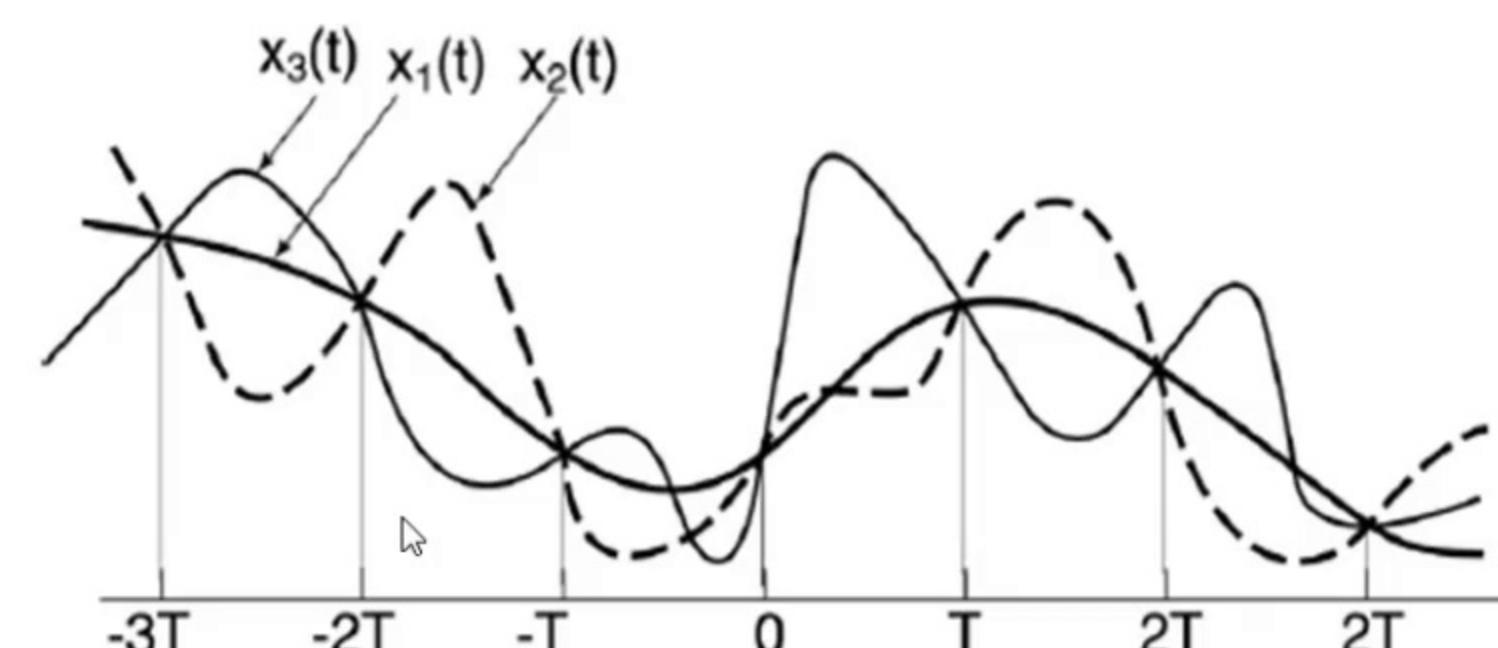
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24 others
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Time Division Multiplexing (TDM)



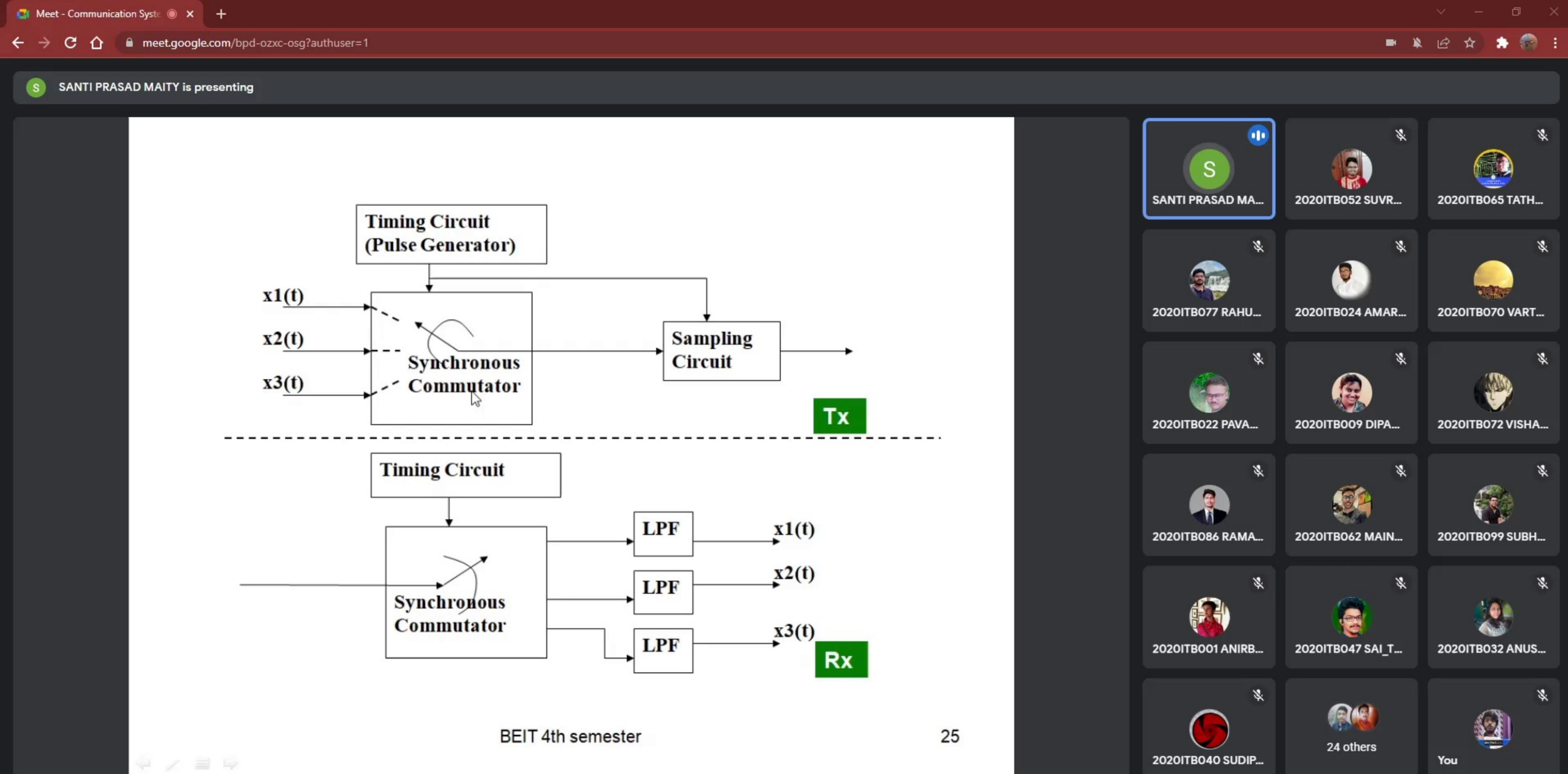
- By sampling we throw out lots of information
 - all values of $x(t)$ between sampling points are lost.

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2020ITB040 SUDIP...
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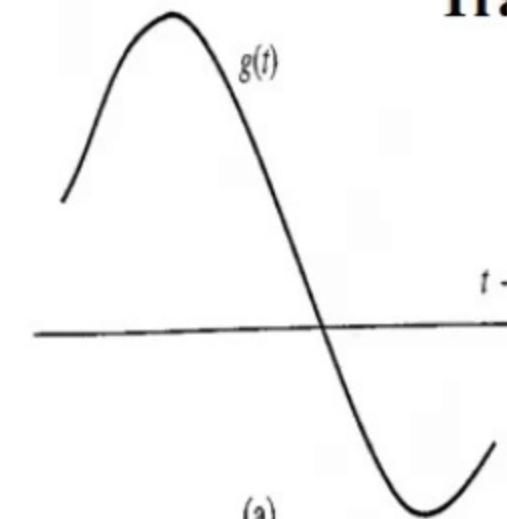


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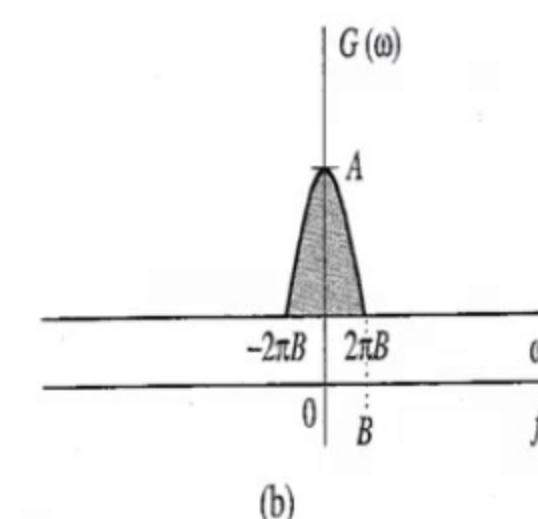
Sampling Theorem

- The signal whose spectrum is band limited to **B Hz** ($G(\omega)=0$ for $|\omega|>B$) can be reconstructed exactly (without any error) from its samples taken uniformly at a rate **$R>2B$ Hz** (samples per second).

$f_s = 2B \text{ Hz}$ Minimum sampling frequency



(a)



(b)



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Advantage and Disadvantage of Pulse modulation over CW

- Pulse modulation advantages over CW modulation
 - i) Transmitted power –concentrated on short duration
 - ii) Time-division multiplexing

Pulse amplitude modulation
Pulse position modulation
Pulse width modulation

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The participant grid displays 20 visible participants and 39 others. The visible participants are:

- SANTI PRASAD MAITY (host, green circle)
- 2020ITB052 SUVR...
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- 2020ITB077 RAHU...
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Pulse Amplitude Modulation

(a) a sinusoid signal

(b) a pulse train

=

(c) Resulting pulse train modulated by the signal

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PAM/AM Transmission and Reception

The diagram illustrates the PAM/AM transmission and reception process. It consists of two main sections: Transmission (top) and Reception (bottom).
Transmission: An input signal $f(t)$ enters a first **Multiplier**. A local oscillator signal $p(t)$ is also fed into this multiplier. The output of the first multiplier is $f_s(t)$, which then enters a second **Multiplier**. This second multiplier receives a local oscillator signal $\cos(\omega_c t)$. The final output is the modulated signal $f_s(t) \cos(\omega_c t)$, represented by a downward-pointing triangle indicating transmission.
Reception: The received signal $f_s(t) \cos(\omega_c t)$ enters a **Demodulator**. This demodulator also receives a local oscillator signal $\cos(\omega_c t)$. The output of the demodulator is fed into a **Low Pass Filter**. The final output is the recovered message signal $f(t)$, indicated by a rightward-pointing arrow.
The entire diagram is labeled "BEIT 4th semester" at the bottom left.

7

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WELCOME to the Course on

SIGNALS AND SYSTEMS

Course Code:IT2104 Classes/Week:03

Weekly Schedule

Tuesday:10:00 hrs-10:50 hrs (by Dr. Santi P. Maity)

Friday: 11:00 hrs-12:50 hrs (by Dr. Santi P. Maity)

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Microphone icon

Screen sharing icon

Hand icon

Document icon

More options icon

Call icon

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Properties of Signals

➤ 1. Time Shifting

$\Phi(t+T) = g(t)$

Whatever happens at t , also occurs in $\Phi(t)$ at T time later at instant $t+T$

- $\Phi(t) = g(t-T)$
- If T is positive , the shift is to right (delay).
- If T is negative , the shift is to left (advance).

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signals_systems intro_L4 (1) - Microsoft PowerPoint

Home Insert Design Animations Slide Show Review View

Tables Picture Clip Art Photo Album Shapes SmartArt Chart Hyperlink Action Text Box Header & Footer WordArt Date & Time Slide Number Symbol Object Movie Sound Media Clips

Slides Outline

WELCOME to the Course on SIGNALS AND SYSTEMS

Properties of Signals

- Time Shifting
- Time Reversal
- Time Inversion
- Time Scaling
- Time Shifting + Time Reversal
- Time Shifting + Time Inversion
- Time Shifting + Time Scaling
- Time Reversal + Time Inversion
- Time Reversal + Time Scaling
- Time Inversion + Time Scaling

Properties of Signals

- Time Scaling: Compression or expansion of a signal in time is known as time scaling
- $\Phi(t/2) = g(t)$; $\Phi(t) = g(2t)$
- $\Phi(t) = g(at)$ (time compression) $T > 2$
- $\Phi(t) = g(t/a)$ (time expansion)

Properties of Signals

- Time Inversion
- $\Phi(-t) = g(t)$ (Fig. 1(a))
- Mirror image of $g(t)$ about vertical axis
- $\Phi(t) = g(-t)$ (Fig. 1(b))
- Mirror image of $g(t)$ about horizontal axis
- $\Phi(t) = g(t)$ (Fig. 1(c))

Unit Impulse Function

- An impulse function can be thought of as a narrow rectangular pulse of unit area.
- The width is very small (Δt) so its height is very large ($1/\Delta t$) in the limit $\Delta t \rightarrow 0$.
- In the limiting case of $\Delta t \rightarrow 0$, $\delta(t) = 0$ for $t \neq 0$.

Click to add notes

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Sampling and Reconstruction

Slide: 1

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Continuous and Discrete Time Signal

Slide: 3

- Signal: Physical quantity that conveys information about some phenomenon and typically exhibits variation in either space or time.
e.g. EM wave, speech signal

Signal in time

Image (2D)

Signal in space

Video Signal

Signal in space and time

Continuous Time Signal
e.g. $x(t)=\sin(2\pi ft)$
Application:
Conventional telephone (PSTN), FM radio, TV Broadcast, etc.

Discrete Time Signal
e.g. $x(n)=\sin(2\pi fn)$
Application:
2D set of grids

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Types of Sources

Slide: 4

- ❑ **A) Analog Source:** Continuous time and continuous valued signal where every point/sample can take any one of **infinite** number of values
Example: Audio Signal captured in a microphone, video signal captured in a video camera.
- ❑ **B) Digital Source:** Energy sample can take **finite** number of values
Example: Binary source, binary file in bits, typing English text.

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Sampling and Quantization (1) [Compatibility Mode] - Microsoft PowerPoint

Slides Outline x

9

10

11

12

13

14

15

Aliasing

Slide: 9

Aliasing: Distortion which occurs due to overlap between samples of signal shifted by multiples of ω_s is termed as Aliasing

Original spectrum of $g(t)$

$$\bar{G}(\omega) = \frac{1}{T_s} \sum G(\omega - n\omega_s)$$

Aliasing occurs if $f_s < B < B_c$, implies $f_s < 2B$

To avoid Aliasing we need $f_s \geq 2B$

Low-Pass Filter

Distortion due to overlap

Loss in Signal Information

Overlap

ω_s

f_s

B

$-2\pi B$

$2\pi B$

$\omega \rightarrow$

$f \rightarrow$

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SANTI PRASAD MAITY is presenting

Pulse Width Modulation

(a) a sinusoid signal

(b) a pulse train

=

Lecture 2 - 2006

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The diagram illustrates the concept of Pulse Width Modulation (PWM). It consists of three horizontal plots sharing a common time axis (t). Plot (a) shows a continuous sinusoidal wave. Plot (b) shows a series of discrete blue rectangular pulses forming a pulse train. A red plus sign between plots (a) and (b) indicates their sum. An equals sign below plot (b) indicates the result of the summation. Plot (c) shows the resulting PWM waveform, which is a series of pulses whose widths vary according to the amplitude of the sinusoidal signal in plot (a).

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Instantaneous Sampling

$$x_p(t) = x(t)p(t) = \sum_{n=-\infty}^{\infty} x(nT)\delta(t - nT)$$
$$p(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT)$$

$\omega_s - \omega_M > \omega_M$

$\omega_s > 2\omega_M$

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Undersampling and Aliasing

When $\omega_s \leq 2 \omega_M \Rightarrow$ Undersampling

$X(j\omega)$

ω

1

$-\omega_M$ ω_M

$P(j\omega)$

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

$-2\omega_s$ $-\omega_s$ 0 ω_s $2\omega_s$ $3\omega_s$ \dots

$X_p(j\omega)$

ω

1

0 ω_s $(\omega_s - \omega_M)$

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Natural Sampling

(a) Input waveform

(b) Sample pulse

(c) Output waveform

Natural sampling: (a) input analog signal; (b) sample pulse; (c) sampled output

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Present sir
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- **Sample and hold**
 - In its simplest form the sample is held until the next sample is taken, so it is of maximum width.
- **Practical example:**
 - Zero-Order Hold,
 - First-Order Hold —Linear interpolation

$x(t)$

$x_p(t)$

$x_0(t) = x_p(t) * h_0(t)$

$p(t)$

$x(t) \rightarrow \times \rightarrow x_p(t) \rightarrow h_0(t) \rightarrow x_0(t)$

$h_0(t)$

1

0

T

t

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Flat-Top Sampling

- Let, $p(t) \rightarrow$ flat topped pulse of duration τ
- Sampled signal,

$$x_s(t) = \sum_{k=-\infty}^{\infty} x(kT_s) p(t - kT_s)$$
$$= p(t) * \sum_{k=-\infty}^{\infty} x(kT_s) \delta(t - kT_s)$$

- This type of sampling is called ***flat topped sampling***
- The spectrum is, [Taking Fourier Transform]

$$X_s(f) = P(f)X_\delta(f)$$
$$= P(f)[f_s \sum_{n=-\alpha}^{\alpha} X(f - nf_s)]$$

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Flat-Top Sampling

- Primarily this sampling technique attenuates high frequencies
- Pulse width is chosen small, $\tau \ll 1/f_s$
- Effect of pulse shape is unimportant and is a good approximation of ideal impulse sampling.

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Figure 1: natural sampling (above) and flat top (below)

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Nonideal reconstruction filter

Figure 1

Figure 2

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Nonideal reconstruction filter

- The filter response shown in first figure is not ideal and cannot suppress spurious components of $x(t)$.
- In Figure 2, we design a filter with increased sampling frequency, with guard band $(f_s - 2f_x)$ Hz.

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The image shows a Google Meet interface. On the left, a slide is displayed with the title 'Nonideal reconstruction filter' and two bullet points about filter design. At the bottom of the slide, it says 'BEIT 4th semester' and '18'. On the right, a grid of participant thumbnails is shown, with one participant highlighted by a blue border. The participants listed are:

- SANTI PRASAD MAITY
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- 2020ITB086 RAMA...
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- 2020ITB005 AVIK...
- 37 others
- You

Participants 2020ITB062 MAIN... and You have a blue border around their thumbnails, indicating they are the presenters or hosts. The participant list has a total count of 55 people.

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Multiplexing Techniques

- Frequency Division Multiplexing
- Time Division Multiplexing
- Multiplexing means simultaneous transmission of several message signals through a common channel or bearer

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2020ITB062 MAIN...

2020ITB001 ANIRB...

2020ITB047 SAI_T...

2020ITB006 AKAS...

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12:25 PM | Communication Systems



Transmitter end

Frequency-Division Multiplexing (FDM)

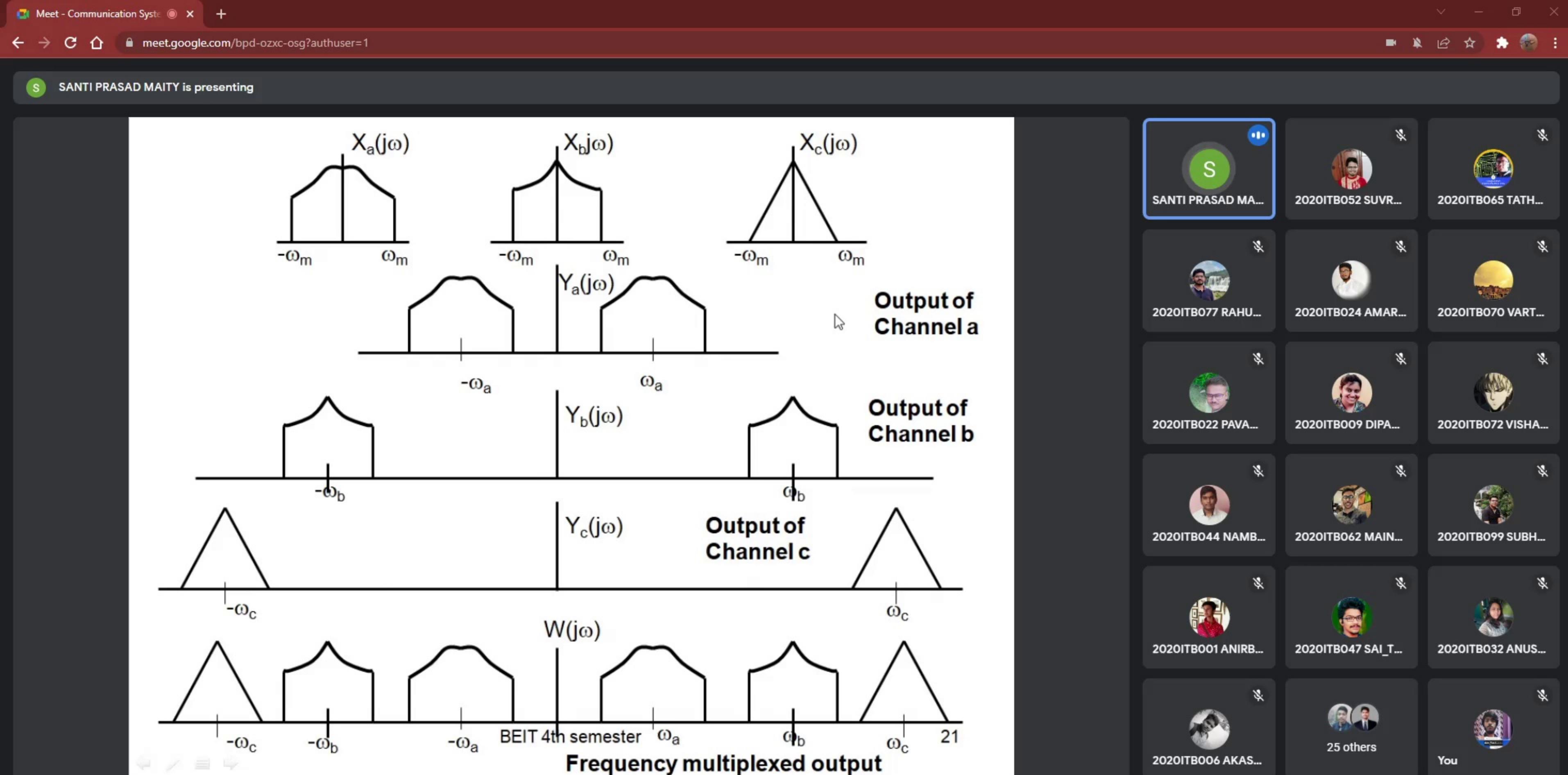
(Examples: Radio-station signals and analog cell phones)

All the channels can share the same medium.

air

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Reconstruction of original signals

```
graph LR; w_t[w(t)] --> BPF_a[BPF(omega_a)]; BPF_a --> Demodulator_a[Demodulator]; Demodulator_a --> x_a_t[x_a(t)]; w_t --> BPF_b[BPF(omega_b)]; BPF_b --> Demodulator_b[Demodulator]; Demodulator_b --> x_b_t[x_b(t)]; w_t --> BPF_c[BPF(omega_c)]; BPF_c --> Demodulator_c[Demodulator]; Demodulator_c --> x_c_t[x_c(t)];
```

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2020ITB070 VART...
2020ITB022 PAVA...
2020ITB009 DIPA...
2020ITB072 VISHA...
2020ITB044 NAMB...
2020ITB062 MAIN...
2020ITB001 ANIRB...
2020ITB047 SAI_T...
2020ITB032 ANUS...
2020ITB006 AKAS...
24 others
You