The LNMIIT, Jaipur
Electronics and Communication Department
Principles of Communication (ECE-XXX)

LNMIIT
The LNM Institute of Information Technology

Subject Code: ECE-XXX	Course Title: **Principles of Communication**	Total Contact Hours: **40**	L: 0	T: 0	P: 0	C: 3
Pre-requisite: **Signals and Systems**		Year: **2nd**	Semester: **Even**			

*** L → Lectures, T → Tutorials, P → Projects C → Credit*

Learning Objective:

This course deals with the basic principles of analog communication techniques. The emphasis is on discussions of both linear and non-linear modulation techniques like amplitude modulation, frequency modulation, etc. In the first term (of about 10 hours) the analytical background needed for studying these methods is prepared. The second term and part of the third term is spent on discussions of the various angle modulation techniques. Understand the process of digitizing the analog signals and digital transmission of analog signals is discussed in the remaining part of the semester.

Course outcomes (COs):

On completion of this course, the students will have the ability:		Bloom's Level
CO-1	**Describe** random variables and processes. **Apply** basic mathematical tools and analytical background in communication systems.	2,3
CO-2	**Outline** and **analyze** the working principles of different linear modulation techniques (AM and its different versions) and associated demodulators	1,4
CO-3	**Outline** and **analyze** the working principles of different non-linear modulation techniques (FM and PM) and associated demodulators	1,4
CO-4	**Determine** and **critically analyze** the performance of different modulation techniques in terms of power utilization, bandwidth requirement, complexity of modulator and demodulator circuits, etc.	3,4
CO-5	**Explain** digital transmission of analog signals and **outline** the process of digitizing the analog signals.	1,2
CO-6	**List** and **illustrate** types of pulse modulation schemes	1,3

Course Topics	Lecture Hours	
UNIT – I (Introduction to Random variable and Processes)		06
1.1 Random variables, probability density function, cumulative distribution function, mean, auto-correlation function, cross-correlation function, power spectral density.	02	
1.2 Transformation of random variables, probability distributions, central limit theorem.	02	
1.3 Random process, classification of random processes, transmission of random process through a linear system.	02	

UNIT – II (Linear Modulation Techniques)		14
2.1 Modulation (single tone & multi tone), need of modulation, pre-envelope and complex envelope, representation of band-pass signals, hilbert transform, fourier transforms of some important functions.	02	
2.2 Classification of AM techniques, conventional AM technique (DSB-C), generation of DSB-C signals (square law modulator, switching modulator), detection of DSB-C signals (envelope detector), double side-band suppressed carrier (DSB-SC), generation of DSB-SC signals (balanced modulator, ring modulator), synchronous detection of DSB-SC signals.	05	
2.3 Single side band (SSB) technique, generation of SSB signals (frequency discrimination method, phase discrimination method), synchronous detection of SSB signals, vestigial side band (VSB) technique.	05	
2.4 Receivers : Tuned radio frequency receiver, superhetrodyne receiver, Image frequency.	02	
UNIT – III (Non-linear Modulation Techniques)		10
3.1 Frequency Modulation (FM) technique, narrowband FM, wideband FM, carson's rule, direct and indirect method to generate FM.	03	
3.2 Demodulators for FM: balanced slope detector, ratio detector, foster-seeley discriminator, phase locked loop, application of PLL and VCO in modulating and demodulating the signals, phase modulation (generation and detection).	05	
3.3 Pre-emphasis, De-emphasis, Frequency division multiplexing	02	
UNIT – IV (Digital Representation of Analog Signals)		10
4.1 Introduction, Why Digitize Analog Sources?, The Sampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse width modulation, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves.	04	
4.2 The Quantization Process, Quantization Noise, Pulse– Code Modulation: Sampling, Quantization, Encoding, Regeneration.	04	
4.3 Differential PCM, Delta Modulation, Adaptive Delta Modulation (ADM)	02	

Text Books:

1. *Principles of Communication Systems*, Herbert Taub, Donald L. Schilling, and Gautam Saha, McGraw Hill, New York, 4th Ed., 2013.
2. *Modern Digital and Analog Communication Systems*, B. P. Lathi, Oxford University Press, 3rd Ed.
3. *Communication Systems*, Simon Haykin, John Wiley Publications, 4th Ed.

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Reference Books:

1. *Communication Systems*, A. Bruce Carlson and Paul B. Crilly, McGraw Hill, New York, 5th Ed., 2011.

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.): NA

Evaluation Methods:	
Item	Weightage
Quiz 1	15
Quiz 2	15
Mid-term Examination	30
End-term Examination	40

Please note, as per the notice circulated in the ECE department on 5th march 2018 students having attendance less than 60% will not be allowed to sit in the final examination.

CO and PO Correlation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	3	1					2	1		3	3	1	
CO 2	3	3	1	1					2	1		3	3	1	
CO 3	3	3	1	1					2	1		3	3	1	
CO 4	3	3		3					2	1		3	3	1	
CO 5	3	2	1						2	1		3	3	2	
CO 6	3	1	1						2	1		3	3	2	

Last Updated On: 18-11-2020

Updated By: Dr. Nikhil Sharma

Approved By:

BASICS OF COMMUNICATION SYSTEM

Signal :- Signal is a function of independent variable that contains some information.

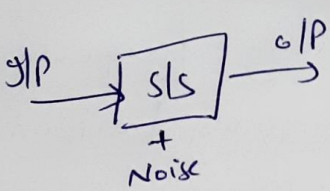
Communication :- It is the process of exchanging information in the form of signals.

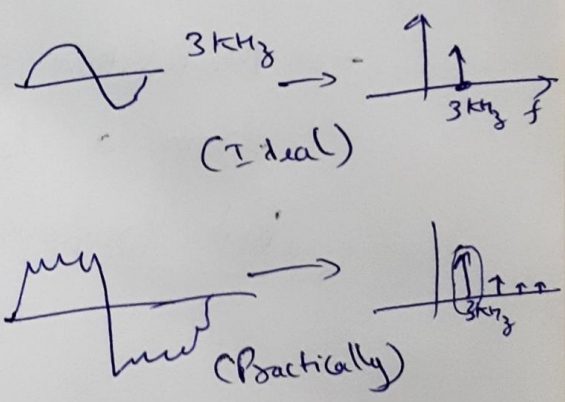
Time domain & Freq. domain Analysis of Signal

- **Advantages of Freq. domain Analysis**
  - (1) System designing becomes easy (Hardware Implementation).
  - (2) Analysis of signal propagating through a system is easy.
  - (3) Easier to implement necessary mathematical operations.
  - (4) Can predict the stability of system.

Eg:

(1)

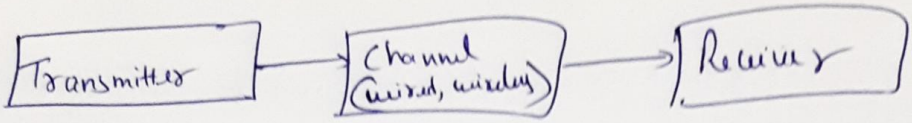




Freq. domain analysis helps in filtering process.

(2) Audible freq. range :- 20Hz – 20KHz

→ Humans speak in range of 500Hz, so microphone tuned to 200 - 800Hz.



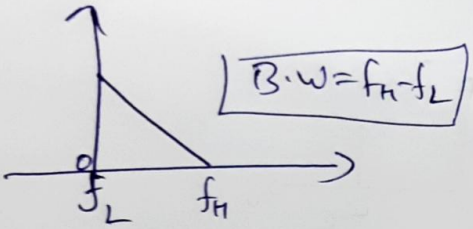
- Message can be Analog or Digital.
- Transmitter :- Transducer + Signal Pre-processing + Modulation
- Message / information signal has low frequency and is a weak signal cannot be transmitted to a longer distance.
- MODULATION :- Process of superimposing the information of a baseband modulating signal (message) on a high freq Carrier signal by altering its characteristics (Amp., freq., Phase).

$$C(t) = A_c \cos(\omega_c t + \theta)$$

→ Modulation is basically frequency translation from a low frequency baseband signal to a high frequency band pass signal.

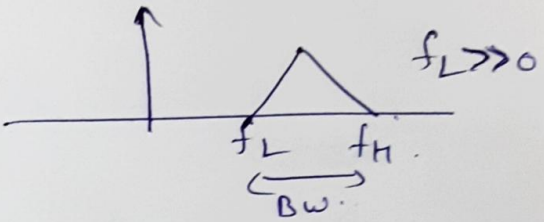
Baseband Signal

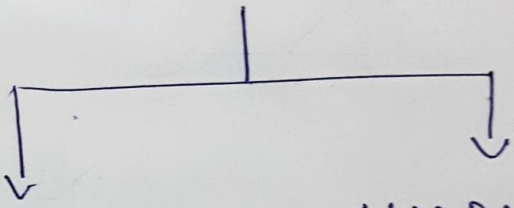
- A low frequency signal having lower cutoff freq. either '0' or very close to zero.



Band Pass Signal

- It represents a high freq. Signal.
- It Exists in a range of frequencies
- Lower Cutoff freq. is much greater than zero.





NARROW BAND SIGNAL

$f_H >> B$

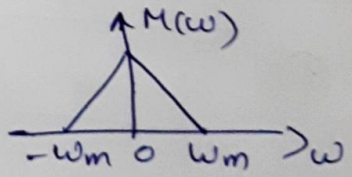
$\frac{f_H}{B} >> 1$

WIDE BAND SIGNAL

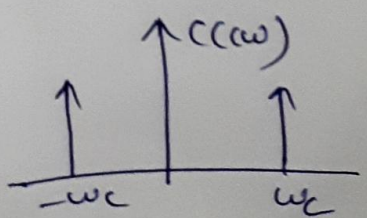
$\frac{f_H}{B} \approx 1$

⇒ MODULATION THEOREM

$m(t)$ → message signal



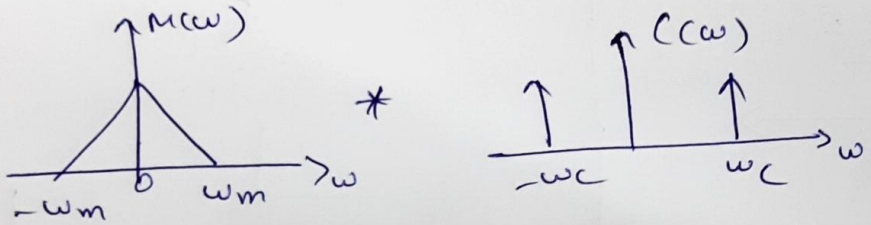
$C(t)$ → Carrier Signal = $A_c \cos\omega_c t$



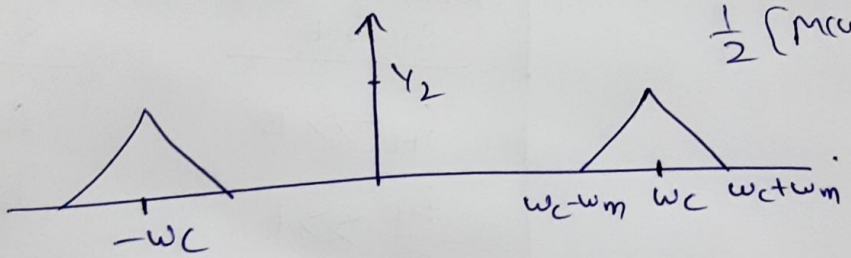
$$m(t) \cdot c(t) \longleftrightarrow M(\omega) * C(\omega)$$

$$M(\omega) * \frac{1}{2}\left[\delta(\omega-\omega_c) + \delta(\omega+\omega_c)\right]$$

$$\frac{1}{2}\left[M(\omega-\omega_c) + M(\omega+\omega_c)\right]$$



$\Downarrow$

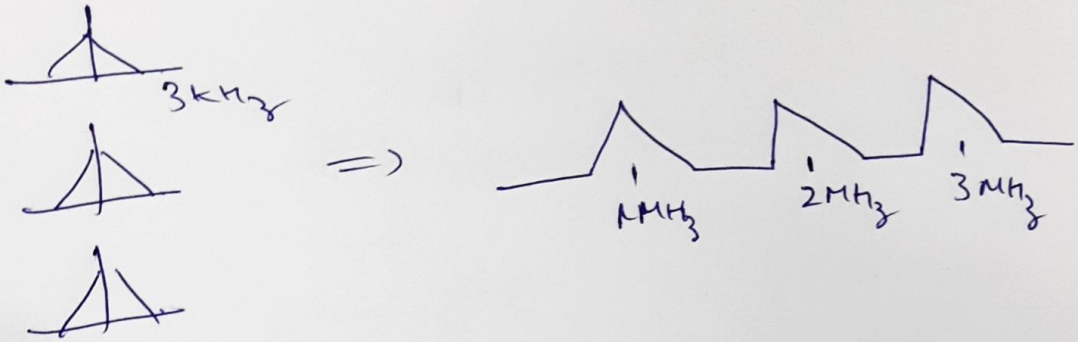


$\Rightarrow$ NEED OF MODULATION

① Height of Antenna :- $\left\{ \lambda = \frac{c}{f} \right.$, $h \propto$

Eg. $f = 15\,kHz$, $h \approx 5\,km$ | $f = 15\,MHz$, $h \approx 5\,m$

(2) Avoids mixing of Signal

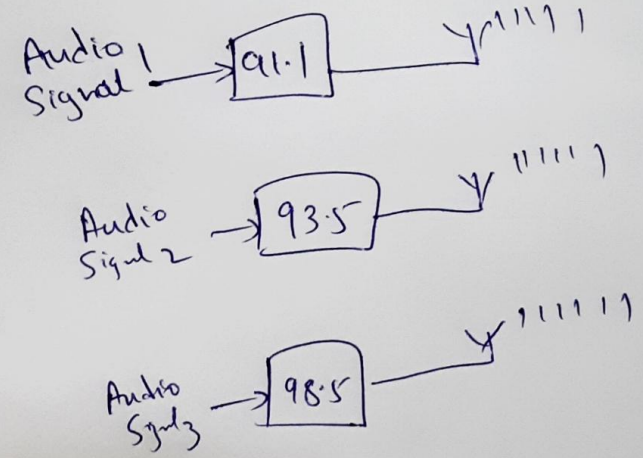


(3) Increase Range of Communication.

(4) Improves quality of Reception

$\left(P \propto \frac{1}{\lambda^2}\right)$, $(f \propto \text{Energy})$

(5) Allows multiplexing



Some Important Transforms

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

$$x(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(\omega)\, e^{j\omega t}\, d\omega$$

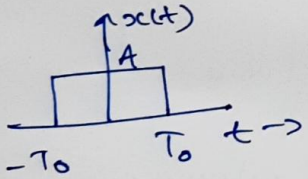
1) $e^{-at}\, u(t) \longleftrightarrow \frac{1}{a+j\omega}$

2) $e^{-a|t|} \longleftrightarrow \frac{2a}{a^2+\omega^2}$

3) $\delta(t) \longleftrightarrow 1$

4) $1 \longleftrightarrow 2\pi\, \delta(\omega)$

5)



$$x(t) = A\, \text{rect}\left(\frac{t}{2T_0}\right) \longleftrightarrow 2AT_0\, \text{Sinc}\left(\frac{\omega T_0}{\pi}\right)$$

6) $\cos\omega_0 t \longleftrightarrow \pi\left[\delta(\omega-\omega_0) + \delta(\omega+\omega_0)\right]$.

$\longleftrightarrow \frac{1}{2}\left[\delta(f-f_0) + \delta(f+f_0)\right]$.

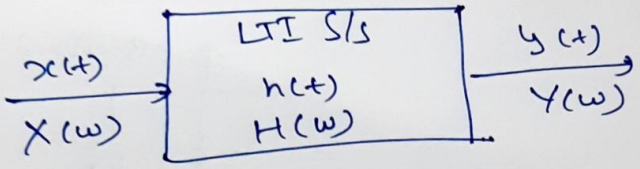
7) $\sin\omega_0 t \longleftrightarrow \frac{\pi}{j}\left[\delta(\omega-\omega_0) - \delta(\omega+\omega_0)\right]$

$\frac{1}{2j}\left[\delta(f-f_0) - \delta(f+f_0)\right]$.

8) $Sgn(t) \longleftrightarrow \frac{2}{j\omega}$.

9) $u(t) \longleftrightarrow \pi\delta(\omega) + \frac{1}{j\omega}$.

⟹ Signal Transmission through LTI S/S.



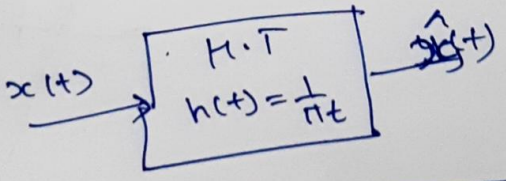
$$y(t) = x(t) * h(t)$$

$$Y(\omega) = X(\omega) \cdot H(\omega).$$

$h(t)$ → Impulse Response

⟹ HILBERT Transform.

- Provides a phase shift of 90°



$$\hat{x}(t) = x(t) * \frac{1}{\pi t}$$

$$\hat{X}(\omega) = X(\omega)\,(-j\,Sgn(\omega))$$

Q Find the F.T. of $g(t) = \frac{1}{\pi t}$)

Sol^n

$$Sgn(t) \longleftrightarrow \frac{2}{j\omega}$$

$$\frac{j}{2\pi} Sgn(t) \longleftrightarrow \frac{1}{\pi\omega}$$

$$x(t) \longleftrightarrow X(\omega)$$

$$\frac{1}{\pi t} \longleftrightarrow 2\pi\, x(-\omega)$$

$$\longleftrightarrow 2\pi \frac{j}{2\pi} Sgn(-\omega)$$

$$\boxed{\frac{1}{\pi t} \longleftrightarrow -jSgn(\omega)}$$

Q $g(t) = A\,Sinc\left(\frac{t}{2\pi}\right)$, $G(\omega) = ?$

$\Rightarrow$ $A\,rect\left(\frac{t}{2T_0}\right) \longleftrightarrow 2AT_0\,Sinc\left(\frac{\omega T_0}{\pi}\right)$

Substituting $2T_0 = 1$

$$A\,rect(t) \longleftrightarrow A\,Sinc\left(\frac{\omega}{2\pi}\right)$$

$$x(t) \longleftrightarrow X(\omega)$$

$$A\,Sinc\left(\frac{t}{2\pi}\right) \longleftrightarrow 2\pi\, x(-\omega) = 2\pi A\, rect(-\omega)$$
$$= 2\pi A\, rect(\omega).$$