Chapter 1

Introduction to COMMUNICATION SYSTEMS

1.1 Basic Communication System

1.2 Baseband and Modulated Signal

1.3 Modulation

1.4 Analog and Digital Signal

Learning Outcomes

At the end of this chapter, the learner will be able to:

1. Explain the principles of a communication systems

2. Discuss the nature of information, different types of signals involved and their characteristics

3. Make the distinction between analog and digital signal

4. Determine the need of modulation and differentiate various type of modulation techniques

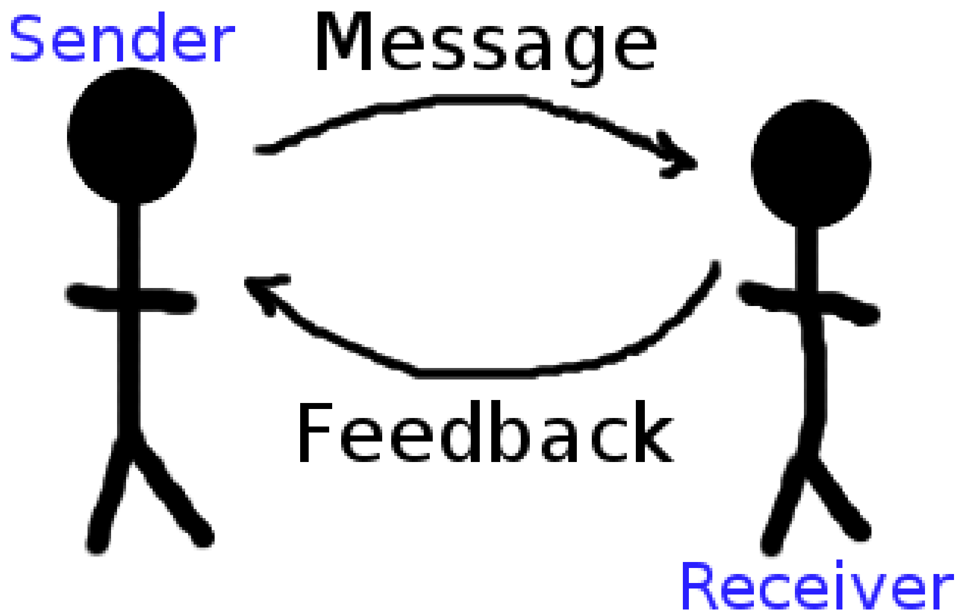
2

What is COMMUNICATION ?

communication

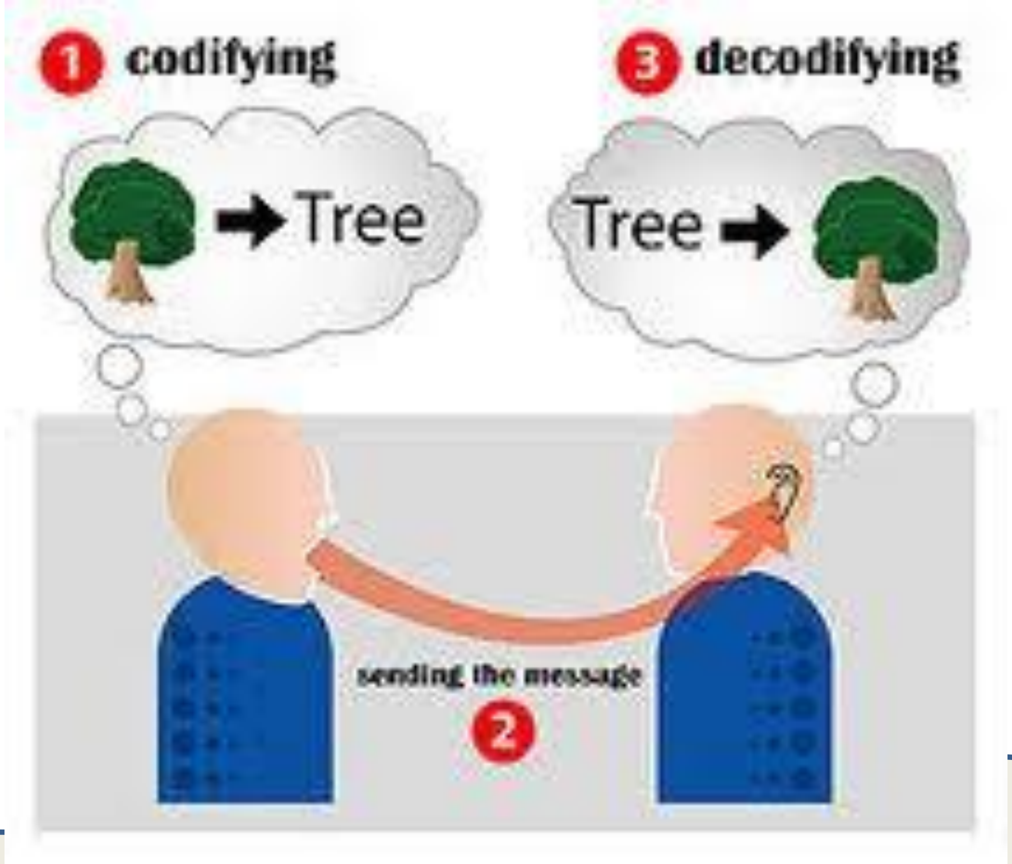
Communication : To transfer information from one place to another

communication



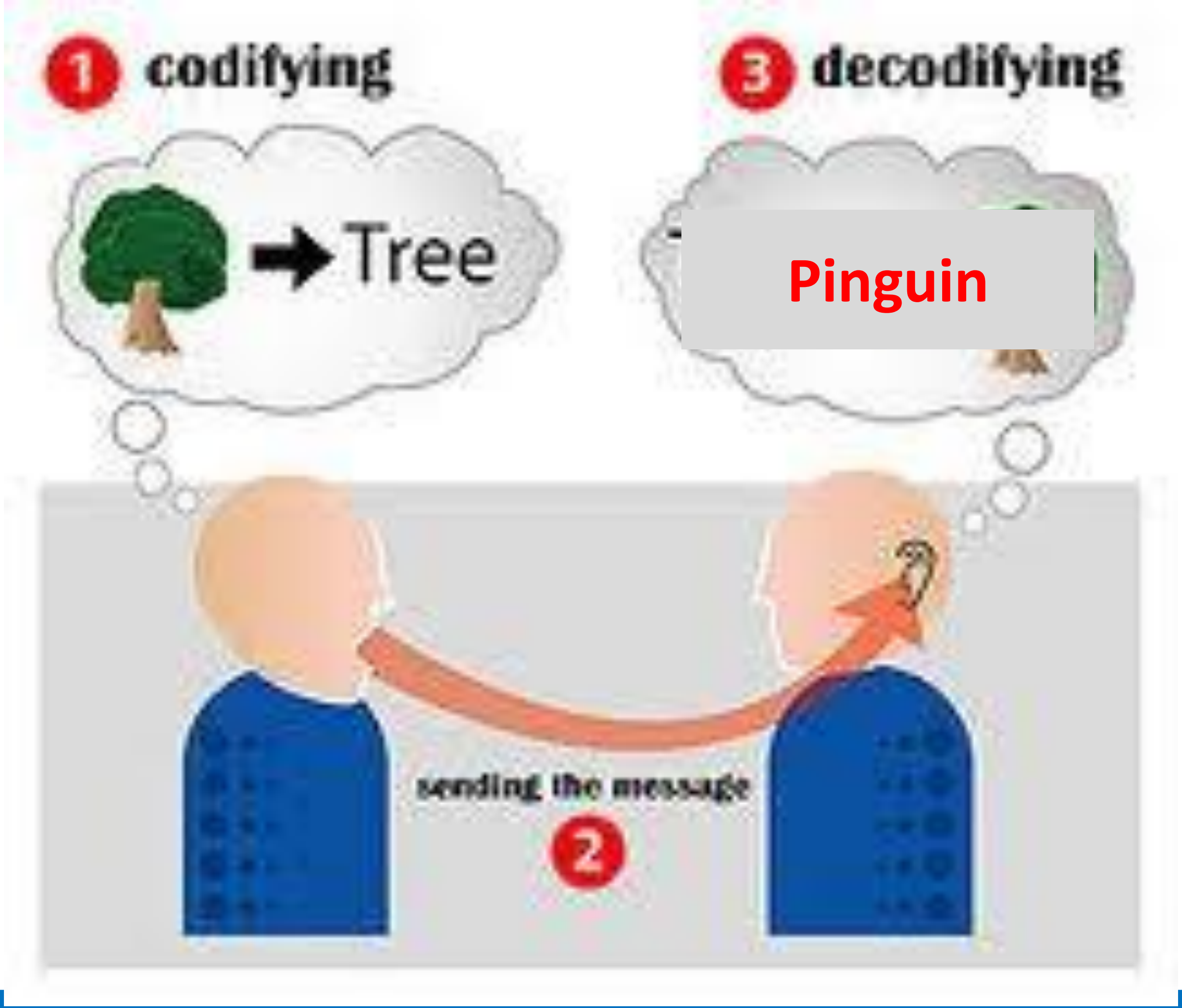
Communication : To transfer information from one place to another

communication



Communication : To transfer information from one place to another

misscommunication



What is INFORMATION ?

Information

Information is a sequence of symbols that can be interpreted as a message. Information can be recorded as signs, or transmitted as signals. Conceptually, information is the message (utterance or expression) being conveyed. The meaning of this concept varies in different contexts

"How do you want to send data/information to someone?"

People communicated by natural senses of hearing and sight.

10

"How do you want to send data/information to someone?"

People communicated by natural senses of hearing and sight.

11

“How do you want to send data/information to someone who is far from you?”

Now,
COMMUNICATION OVER LONG DISTANCES is very easy.

"How do you want to send data/information to someone who is far from you?"

NOW….. Various communication technology are available and ready to help us

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Communication System History

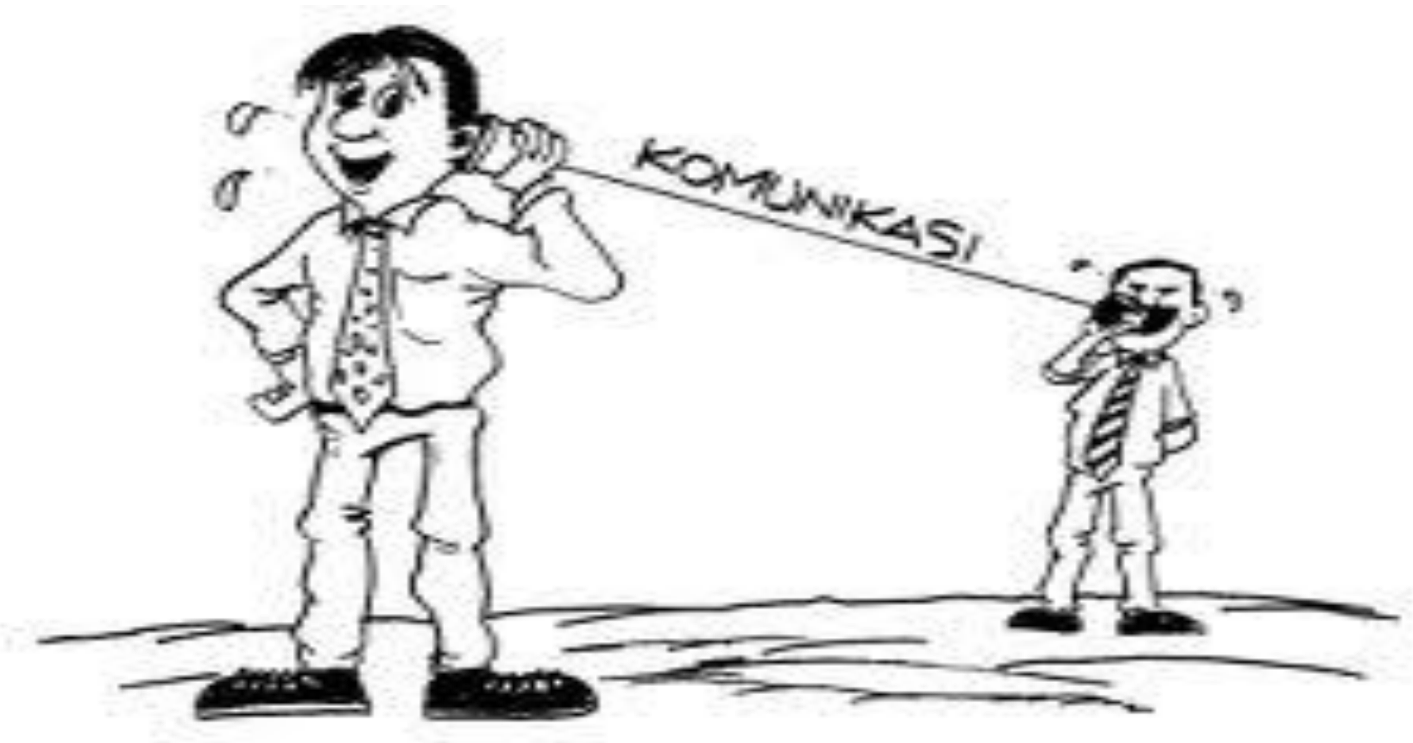
- **1837 – Samuel Morse invented telegraph.**
- **1858 – First telegraph cable across Atlantic (Canada – Ireland)**
- **1876 – Alexander Graham Bell invented telephone.**
- **1988 – Heinrich Hertz introduce electromagnetic field theory.**
- **1897 – Marconi invented wireless telegraph.**
- **1906 – Radio communication system was invented.**
- **1923 – Television was invented.**
- **1938 – Radar and microwave was invented for World War II.**
- **1950 – TDM was invented.**
- **1956 – First telephone cable was installed across Atlantic.**
- **1960 – Laser was invented**
- **1962 – Satellite communication**
- **1969 – Internet DARPA**
- **1970 – Corning Glass invented optical fiber.**
- **1975 – Digital telephone was introduced.**
- **1985 – Facsimile machine.**
- **1988 – Installation of fiber optic cable across Pacific and Atlantic.**
- **1990 – World Wide Web and Digital Communication.**
- **1998 – Digital Television.**

Tele…..

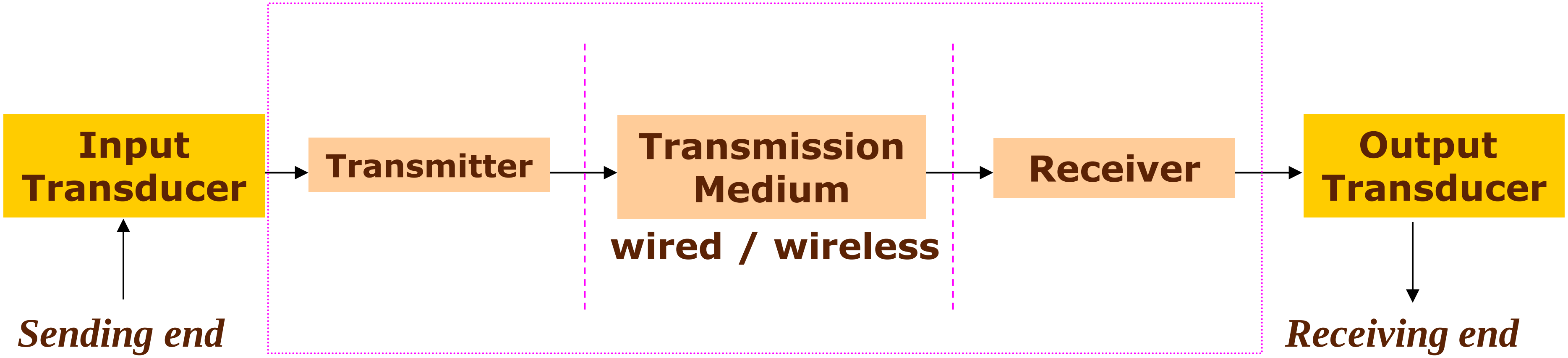
- The words "tele", "phon", and "graph" are derived from Greek.
  - Tele – means ‘at a distance’
  - Phon – means sound or speech
  - Graph - means writing or drawing

- Therefore, telecommunication means communication at a distance.
- This can be done through wires called transmission lines or through atmosphere by a radio link (wireless). Other examples include:
  - Telephone – speaking at a distance
    Telegraph – writing at a distance
  - Television – seeing at a distance

Basic Communication System



Sending end	Transmission Channel	Receiving end



Components in Basic Communication System

- **Input Transducer – convert input signal in electrical forms. eg: microphone.**
- **Transmitter – involve modulation process and finally transmit the signal.**
- **Transmission medium – connecting the transmitter and the receiver that enable the modulated signal propagate through the medium.**
- **Receiver – receive the modulated signal and then convert the signal to modulating signal through the process called demodulation.**
- **Output Transducer – convert the modulating signal to its original forms (output signal) that is useful to the users. eg: loud speaker.**

Why need modulation in transmitter?

ILLUSTRATION

Highway is available for you to move from City A to City B

How do you do to move ?

Highway is available for you to move from City A to City B

BASEBAND

Just walk on the highway, 5km/h

Highway is available for you to move from City A to City B

Use your legs, 5km/h

BASEBAND

Highway is available for you to move from City A to City B

MODULATED

Use bicycle, 20 km/h

Highway is available for you to move from City A to City B

Use car, 120 km/h

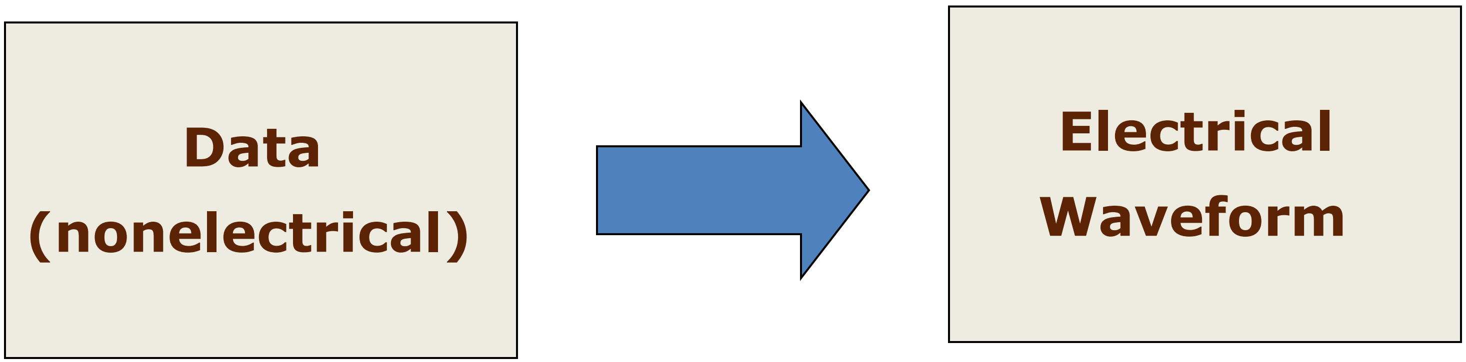
MODULATED

BASEBAND

The signal is in its original form, not changed by modulation.

Baseband **is transmission of signal at its original frequencies.**

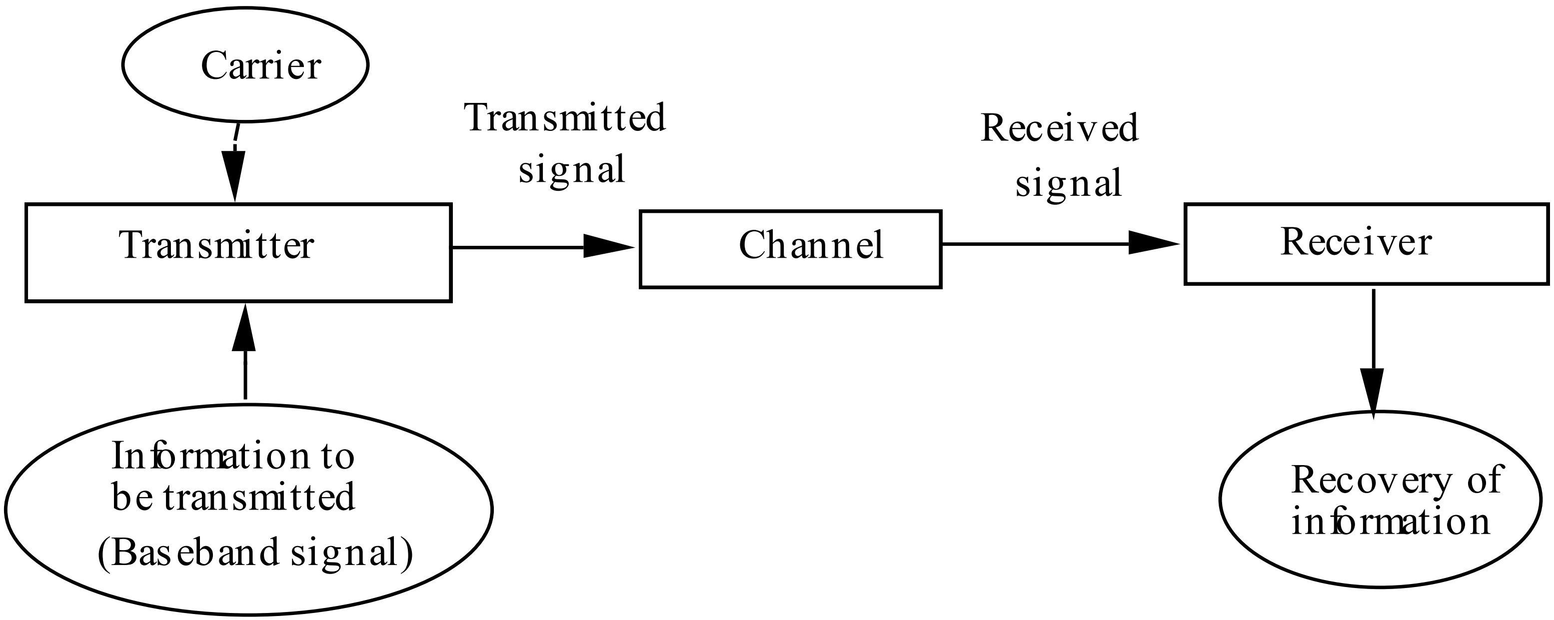
BASEBAND



The signal is in its original form, not changed by modulation.

Baseband **is transmission of signal at its original frequencies.**

Baseband and modulated signal



WHAT IS CARRIER ?

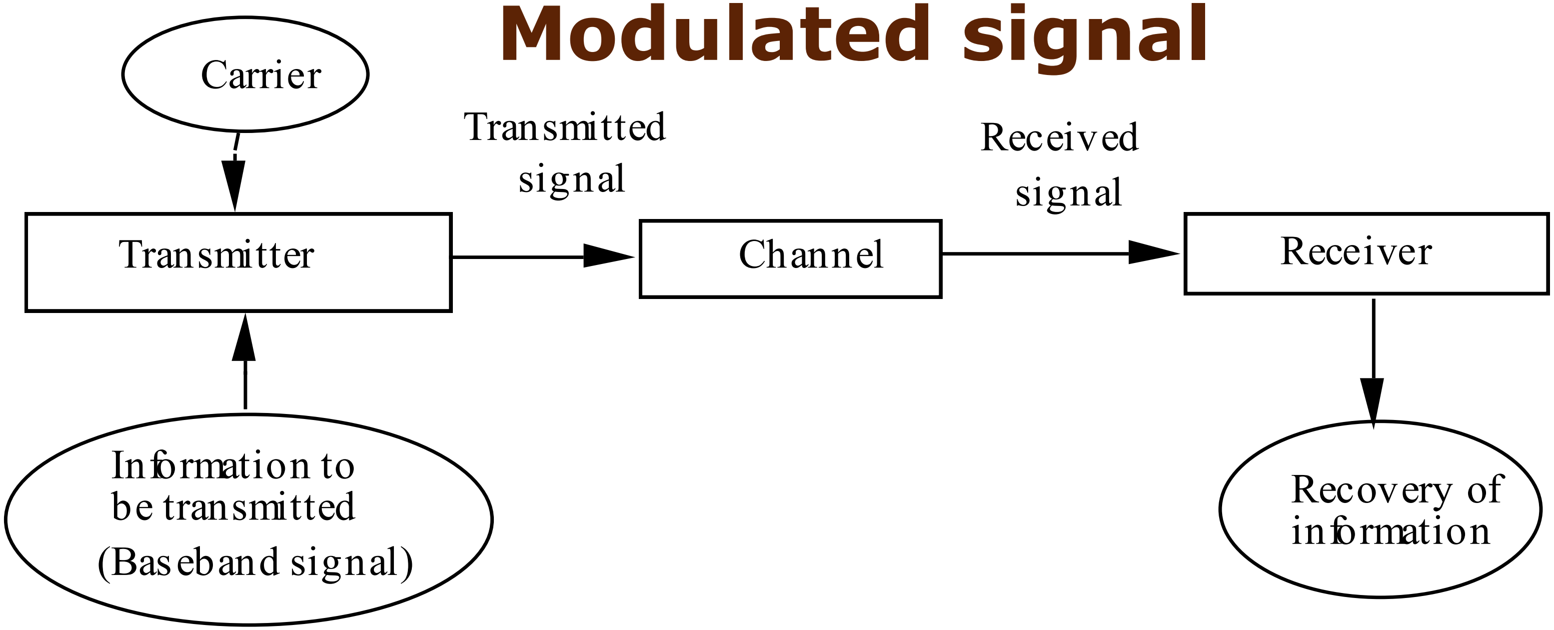
WHAT IS CARRIER ?

Transferring information at high frequency

illustration:

Motorcycle/Car/bus is CARRIER to bring the person (information) travel via high speed toll

Modulated signal



WHAT IS MODULATION ?

3 signals in modulation

Modulating signal

Carrier signal

Modulated signal

MODULATION

Modulation is the **process of changing** some properties of the information sources **into suitable form** for transmission through the physical medium/channel

*It is performed in the transmitter by a device called **Modulator**.*

DEMODULATION

Demodulation is the **reverse process of modulation** by converting the modulated information sources back to its original information (it removes the information from the carrier signal).

*It is performed in the receiver by a device called **Demodulator**.*

Modulation

Transferring information at high frequency

modulation

Human voice frequencies in the studio contain signals between 300 Hz and 3000 Hz

modulation

Broadcast	frequency
AM Radio	: 531-1611 Hz
FM Radio	: 88-108 MHz
Cellular, GSM	: 900/1800 MHz
Satellite	: 30 GHz

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THE NEED OF MODULATI

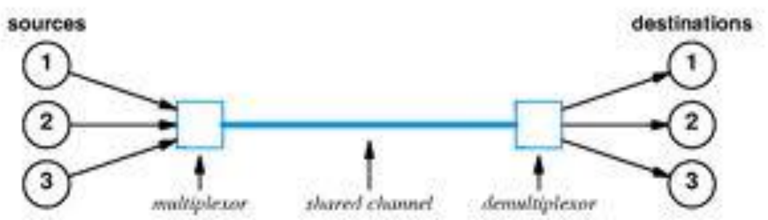
1. Channel assignment (various information sources are not always suitable for direct transmission over a given channel)

(human voice can be transmit using);

- Channel for radio
- Channel for television
- Channel for telephone

THE NEED OF MODULATI

2. Permits frequency division multiplexing



Bus, truck, car, motorcycle,...

Kuala Lumpur

Terengganu

Johor Bahru

(human voice can be transmit using);

- Channel for radio (IKIM FM, Sinar FM, Pantai Timur FM, Pantai Barat FM,....)

THE NEED OF MODULATI

3. Higher frequency can give more efficient transmission

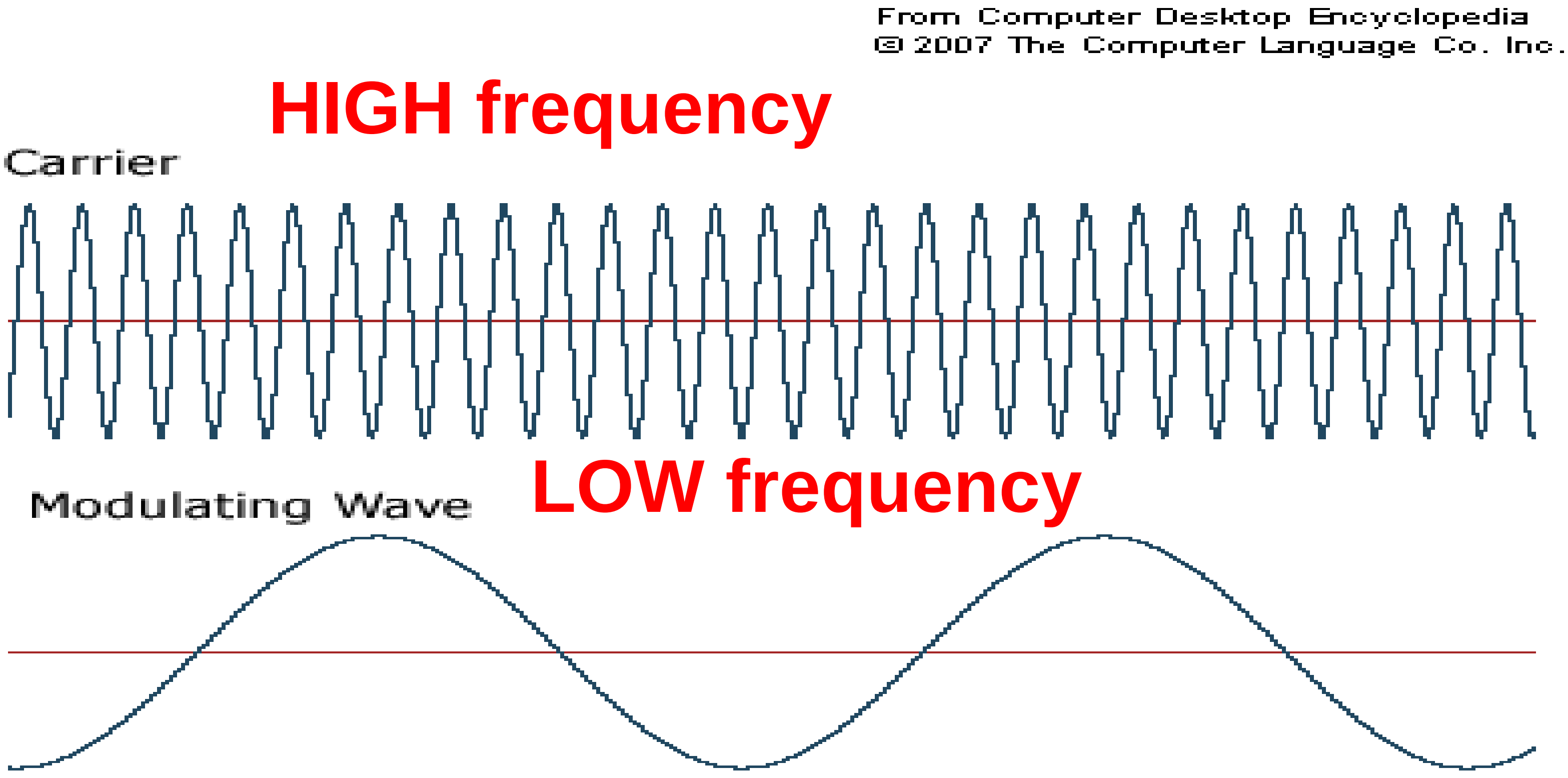
4. Reduce noise & interference

5. Overcome equipment limitation

TYPE OF MODULATION

- Example:
  - Amplitude Modulation (AM)
  - Frequency Modulation (FM)
  - Phase Modulation (PM)

Amplitude Modulation



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PM and FM of sine-wave signal

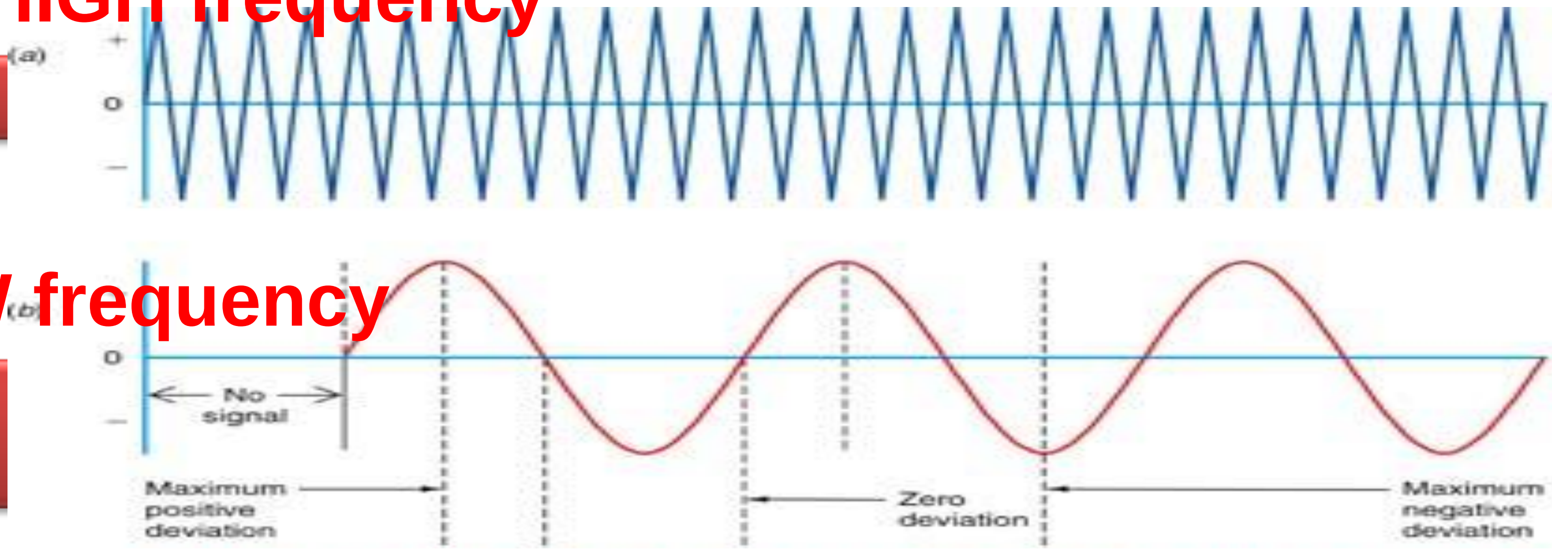
FREQUENCY MODULATION

HIGH frequency

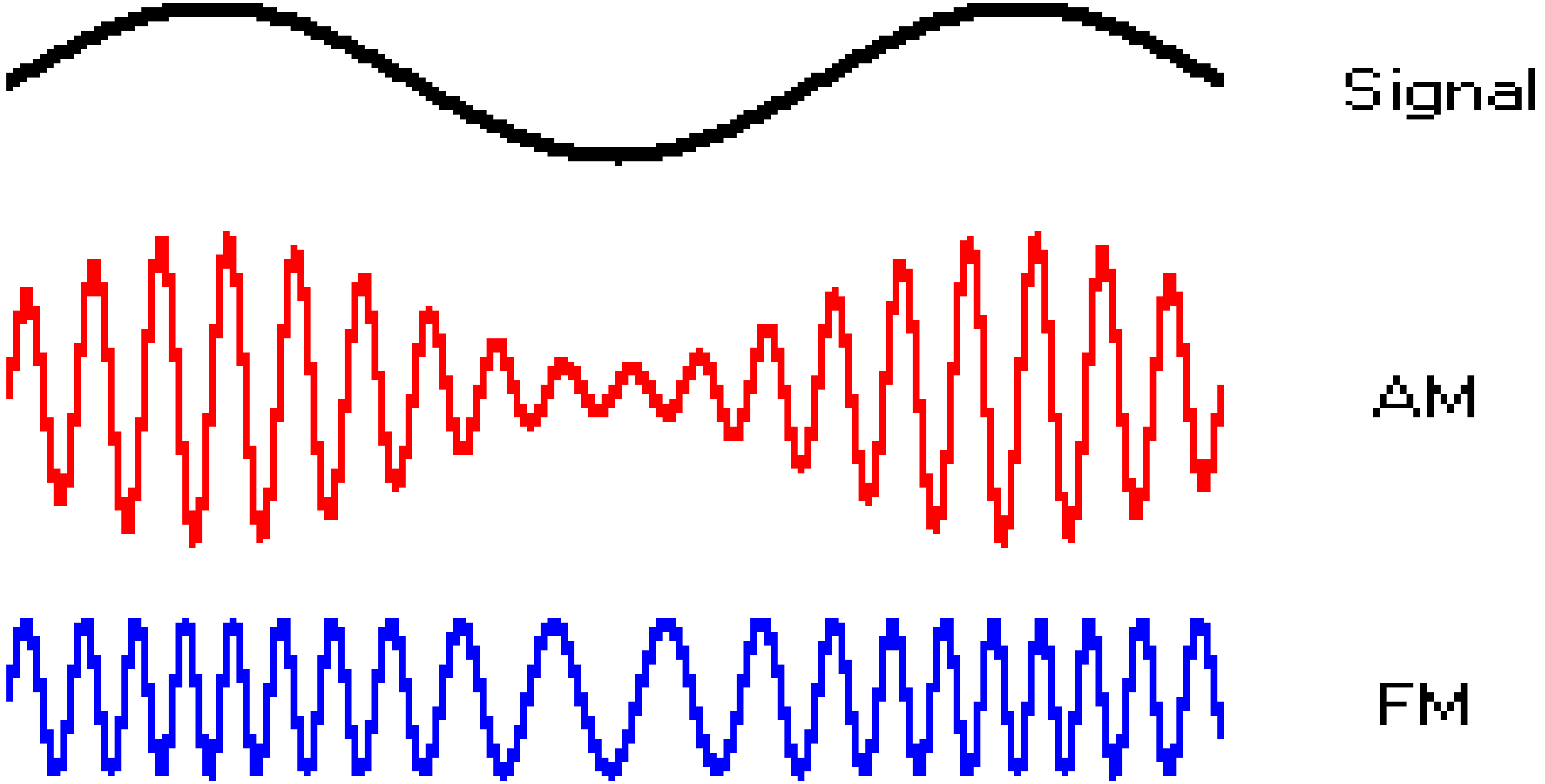
Carrier

LOW frequency

Modulating signal

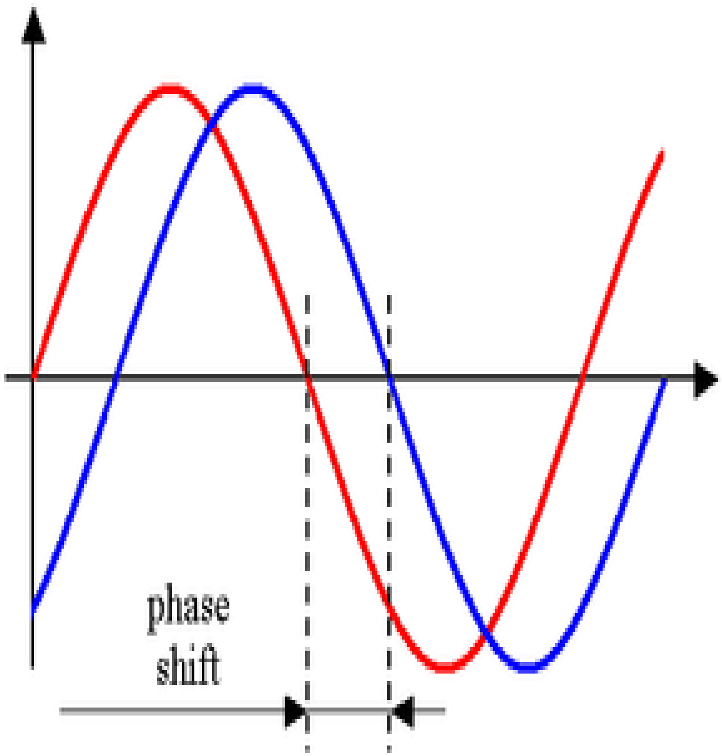


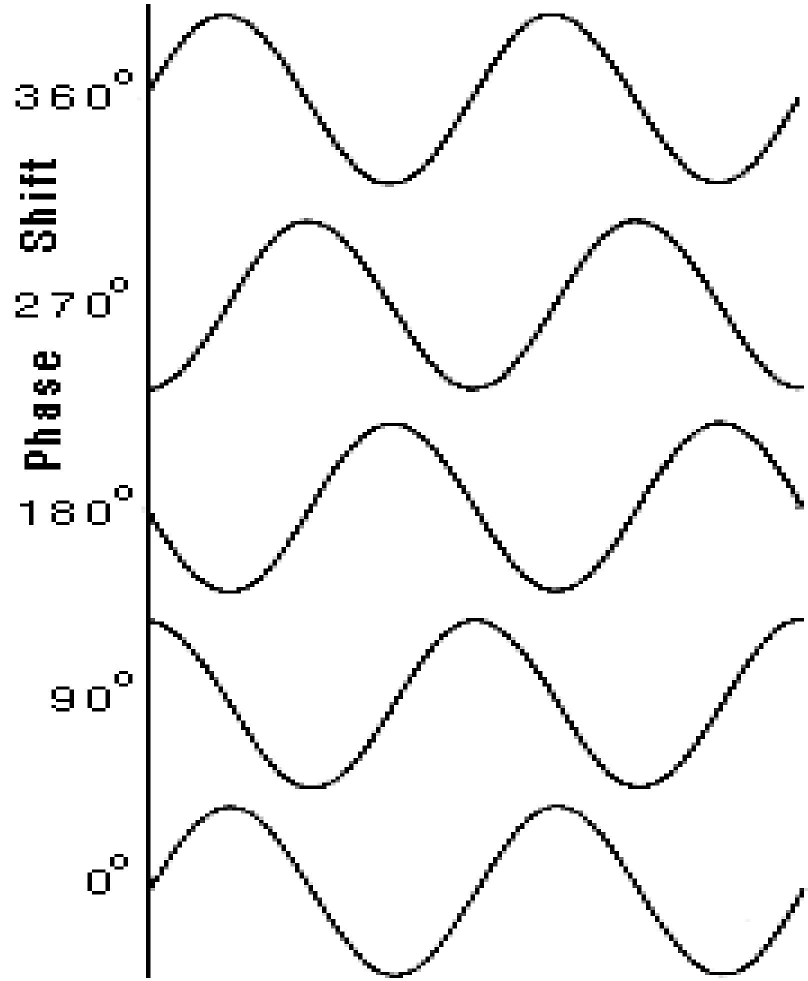
Type of modulation



Phase Shift

difference or change in the *initial phase*.





SNEAK PEAK TO OTHER CHAPTERS

Chapter 2: AM

2.1 Various Types of AM,
2.2 Voltage, Power, Modulation Index and Efficiency
2.3 Time, Frequency Domain Waveform and Bandwidth
2.4 Double Side Band, Single Side Band and Vestigial Side Band, Suppressed Carrier AM
2.5 AM, DSB, SSB Modulator/Demodulator
2.6 SHF Receiver
2.7 Noise in AM System

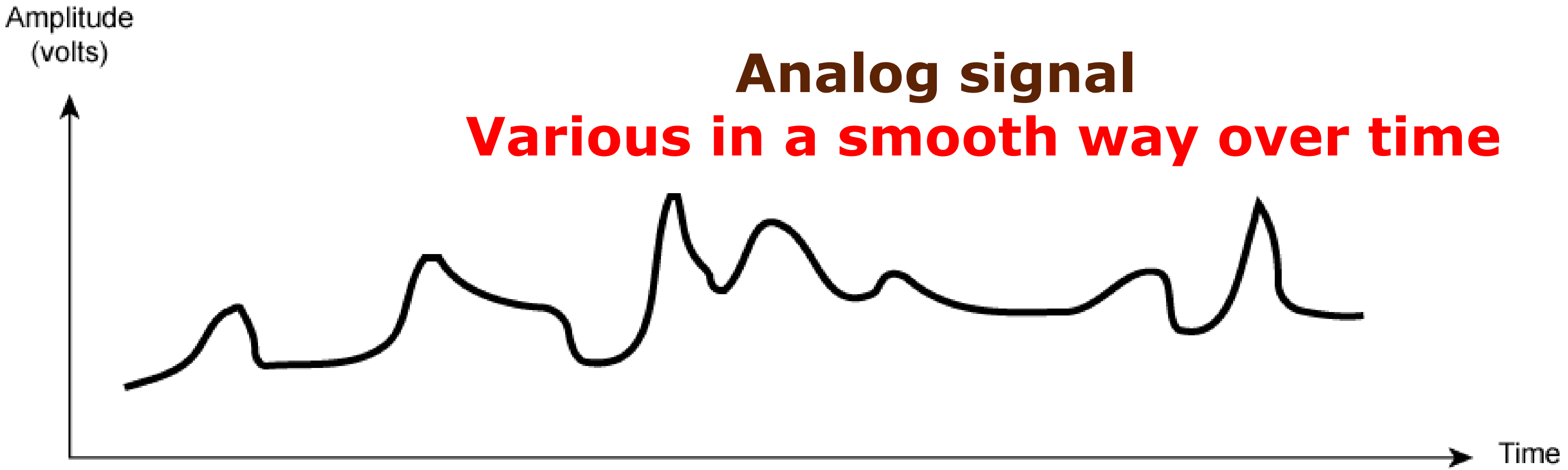
Chapter 3: FM, PM

3.1 Angle Modulation: FM and PM
3.2 Advantage of FM Over AM
3.3 FM: Narrowband and Wide Band
3.4 Bessel Function, Bandwidth, Frequency Deviation, Power, Index Modulation
3.5 FM Modulator/Demodulator
3.6 Pre-Emphasize/De-Emphasize
3.7 Noise Effect on FM

Analog form such as Human Voice or Music

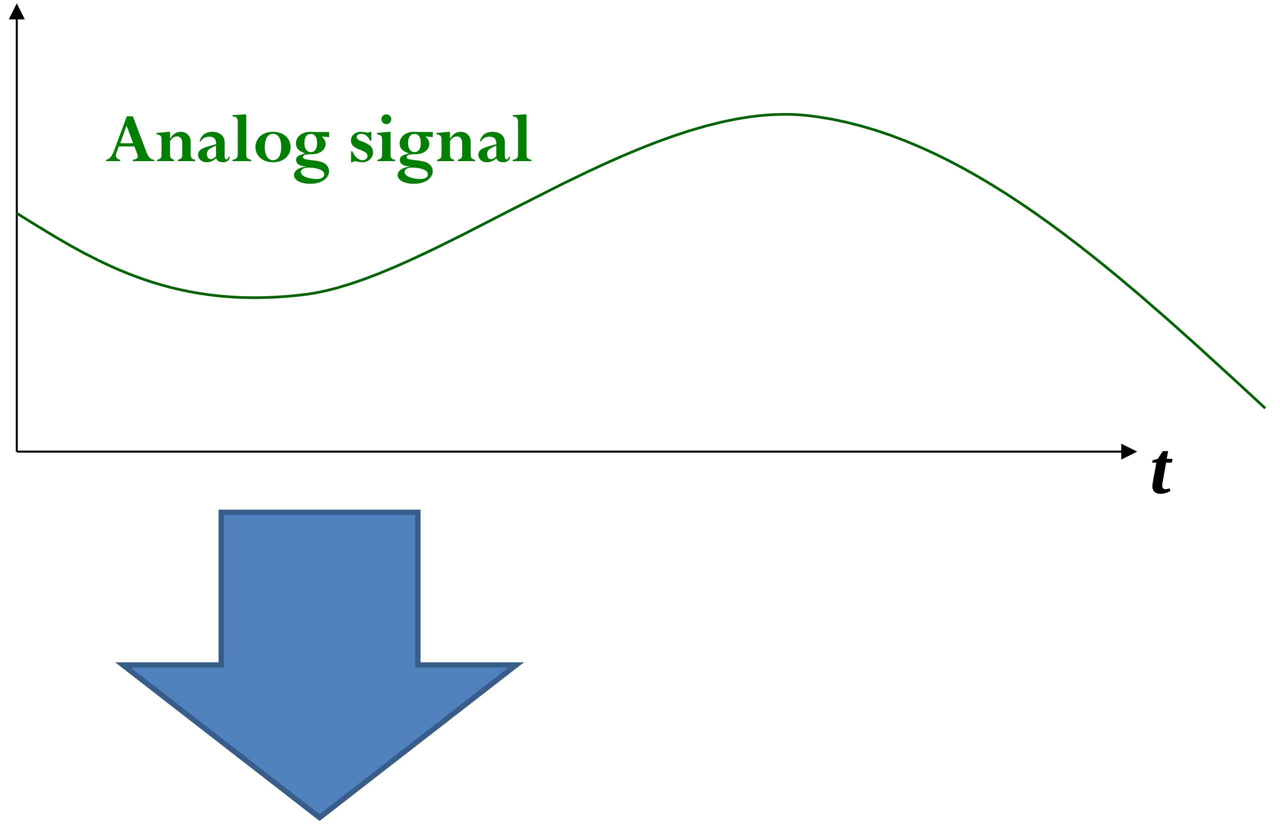
Analog signal

Various in a smooth way over time



(a) Analog

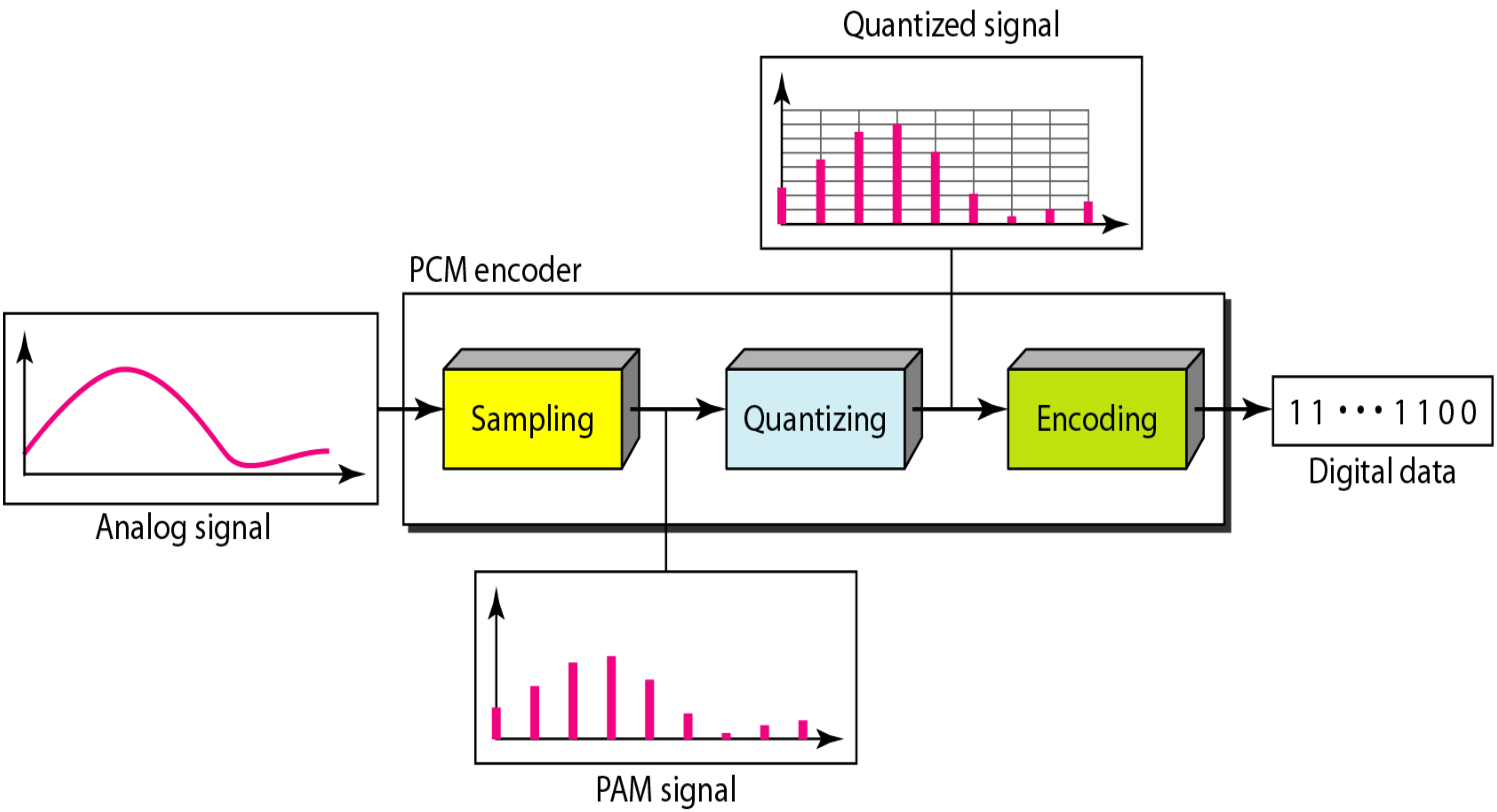
Analog to digital conversion



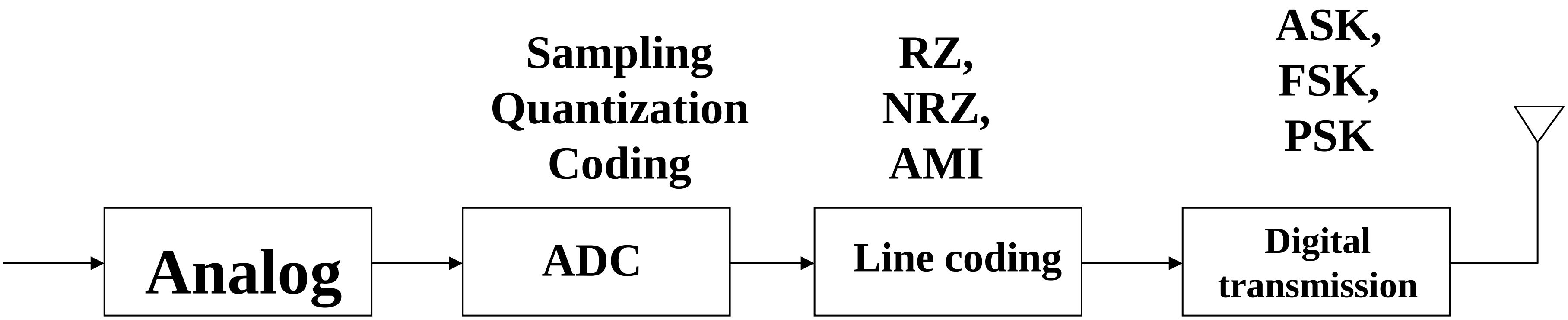
Digital signal

0 0 0 1 0 1 0 1 0 1 1 1 1 1 1 1 0 0 0 1 0 0 0 0 0 010101010101

PCM


Quantized signal
PCM encoder
Sampling
Quantizing
Encoding
1 1 • • • 1 1 0 0
Digital data
Analog signal
PAM signal

digital transmission system



WILL BE DISCUSSED IN CHAPTER 4

Chapter 4: Digital Modulation

4.1 Types of Digital Modulation
4.2 Pulse Modulation
4.3 Binary Modulation (Shift Keying Modulation)
4.4 Pulse Code Modulation
- Sampling; Nyquist's Theorem
- Quantization; Uniform/Non-Uniform
- Coding

4.5 Delta Modulation, DPCM, ADPCM
4.6 Line Coding: Manchester, NRZ, …..
4.7 Multiplexing; FDM, TDM
4.8 Noise in Digital System (bit error rate)

Some applications of Communication system

CHAPTER 5

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Chapter 5: Communication Systems

5.1 Telephone Network
5.2 Cellular System
5.3 Microwave radio systems
5.4 Optical Fiber Communication
5.5 Satellite Communication
5.6 Data communications and Networks

Now……

Refreshing

What is Wavelength ?

What is Frequency ?

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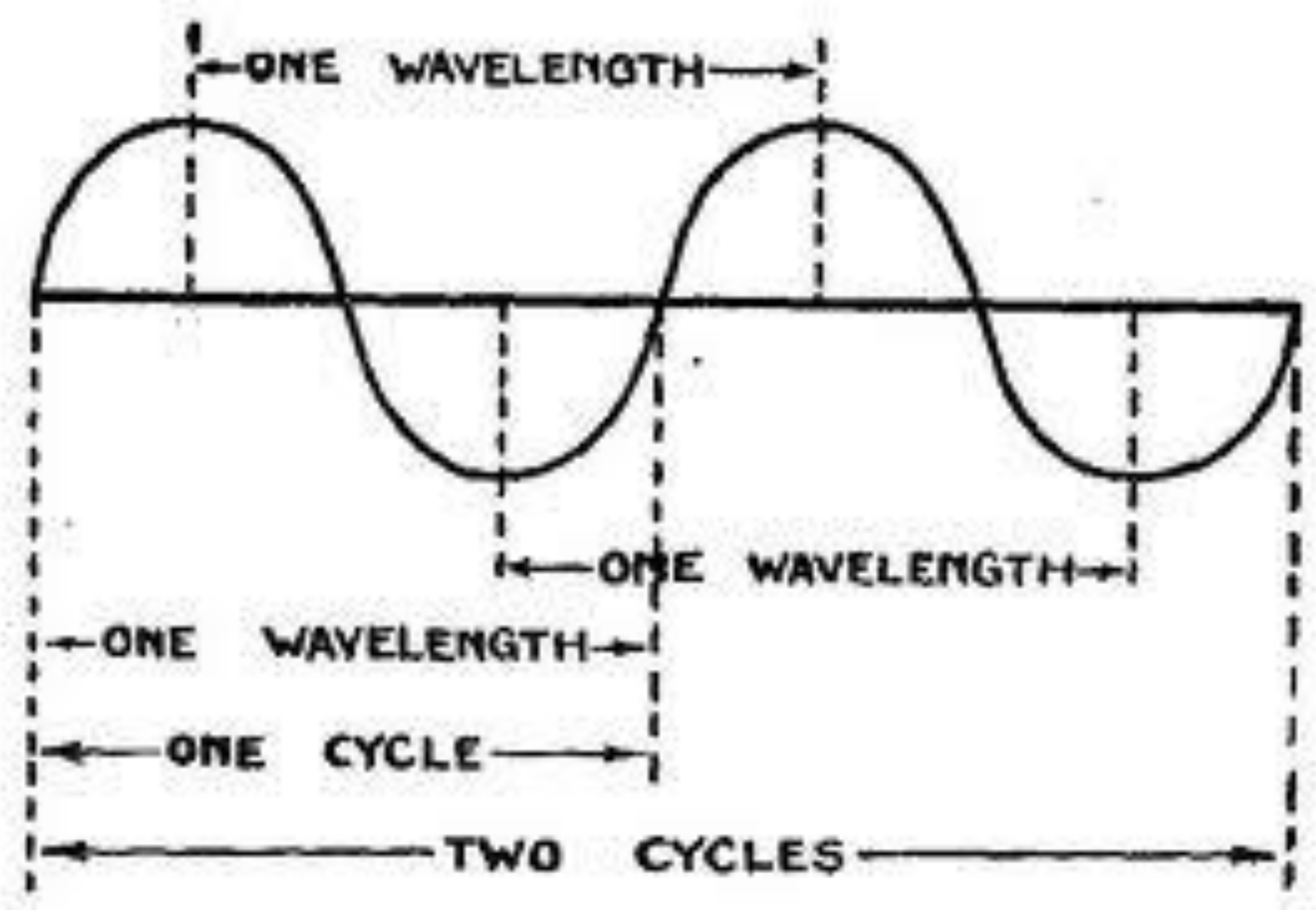
Wavelength

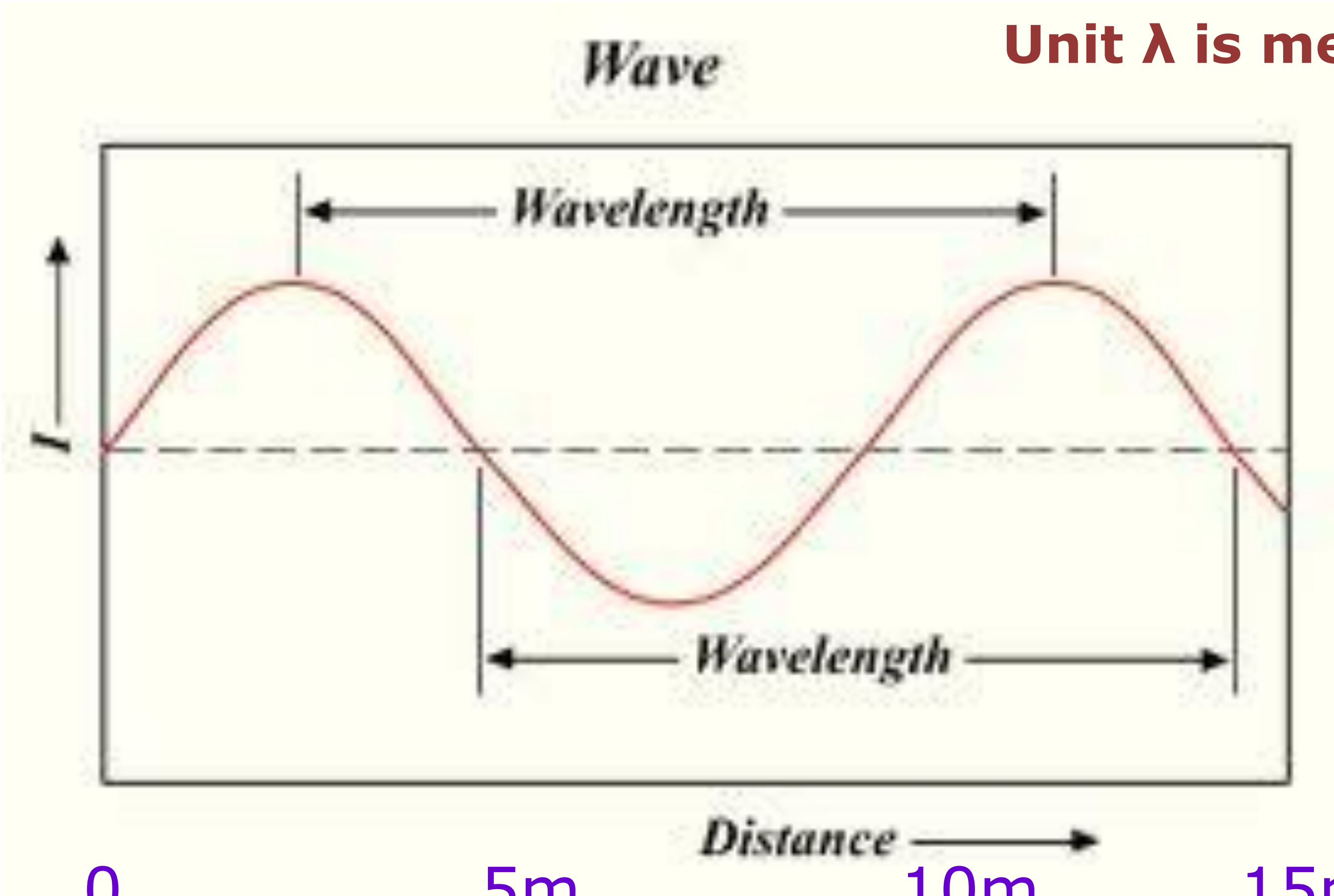


Wavelength (λ) = 1 cycle of signal

in meter (m)

Wavelength

Unit λ is meter (m)



Wavelength (λ) = 10m

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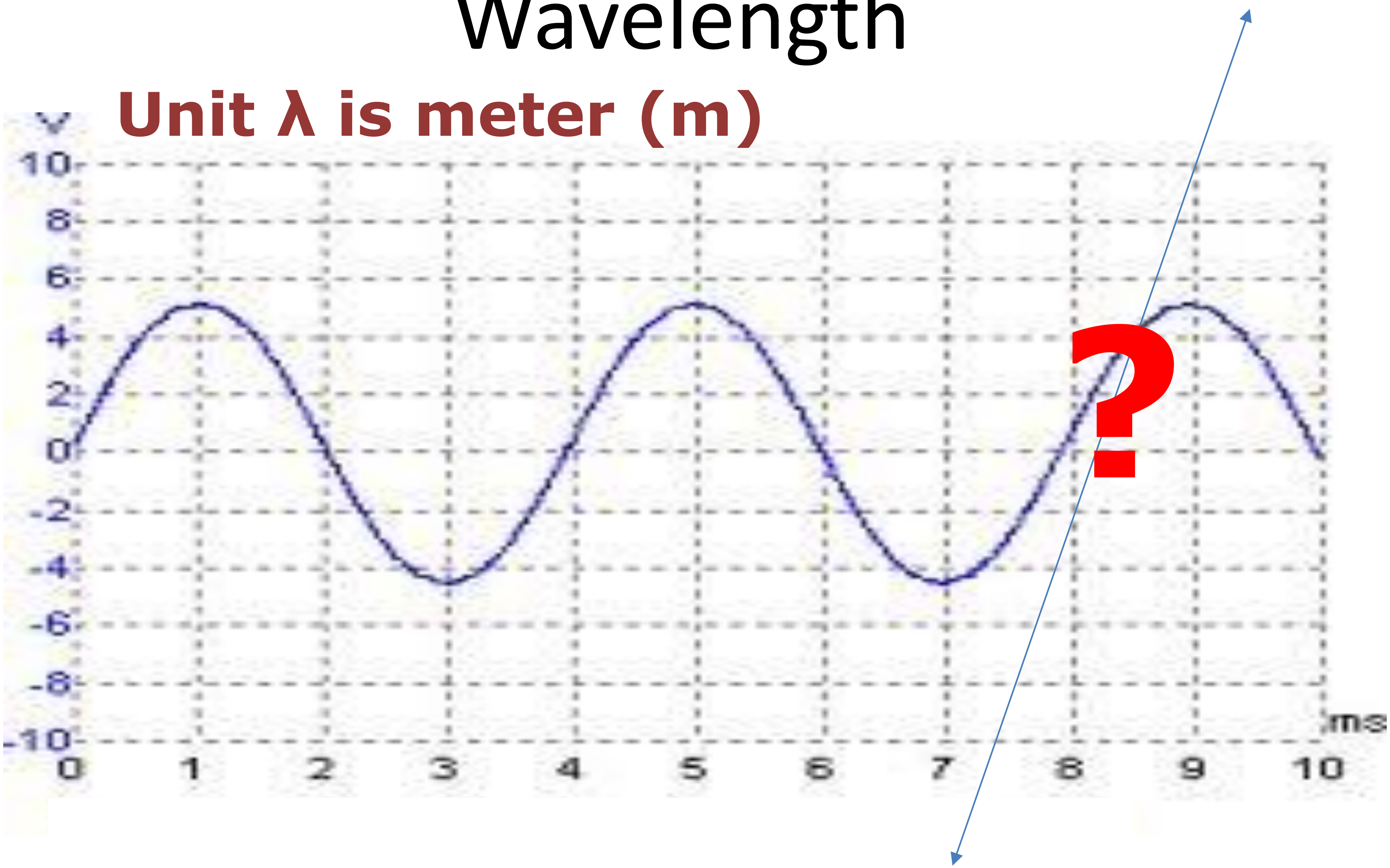
Wavelength

Unit λ is meter (m)



Wavelength (λ) = 10ms

Wavelength

We know
c = speed of light
$= 3 \, x \, 10^8$ **m/s**

10ms → 10ms x $3 \, x \, 10^8$ **m/s**

λ = $(10 \, x \, 10^{-3} \, s) \, x \, (3 \, x \, 10^8$ **m/s)**

λ = $30 \, x \, 10^5$ **m**

λ = $3 \, x \, 10^6$ **m**

?

Unit λ is meter (m)

Wavelength (λ) = 10ms

$= 3 \, x \, 10^6$ **m**

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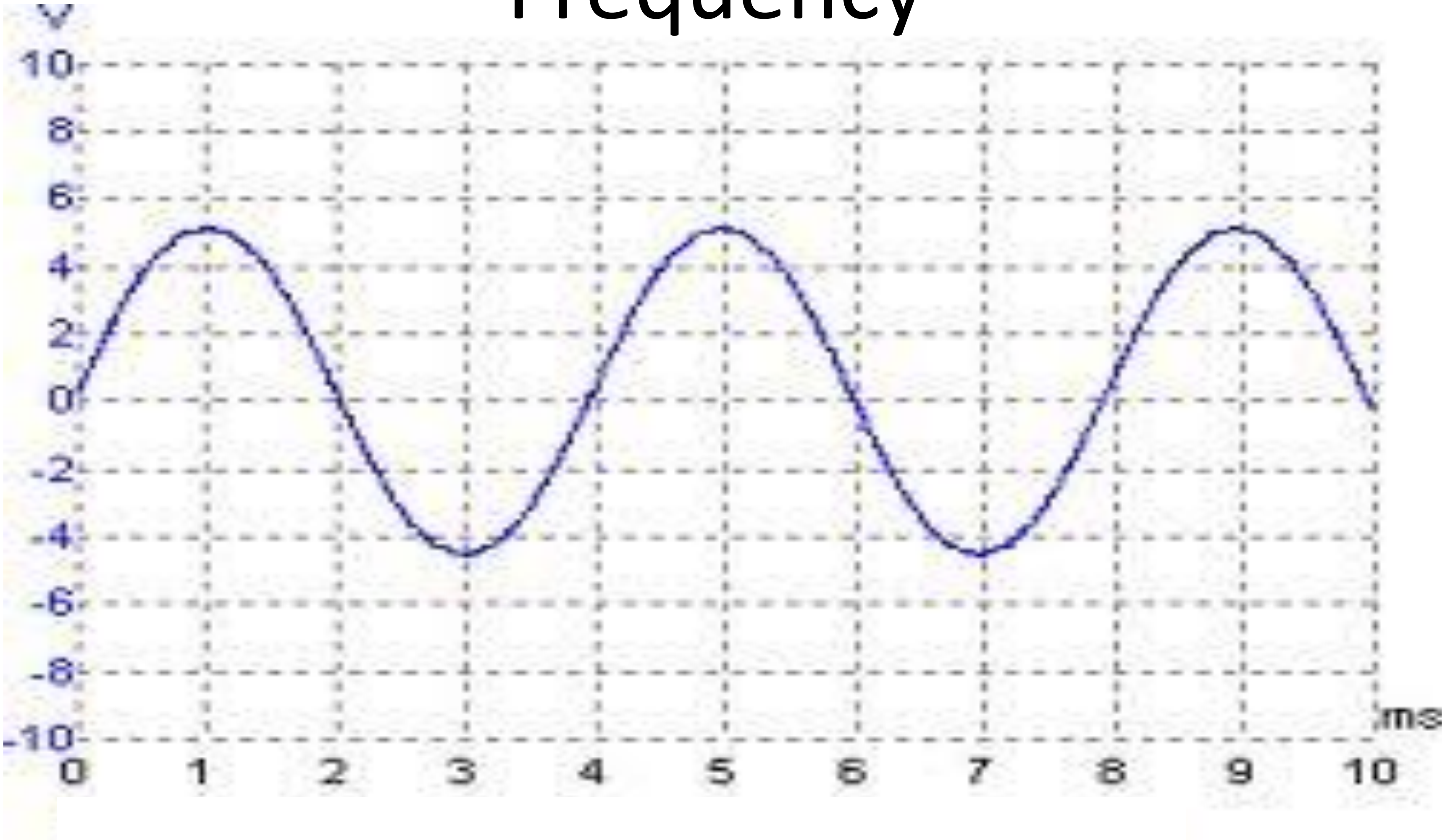
Frequency



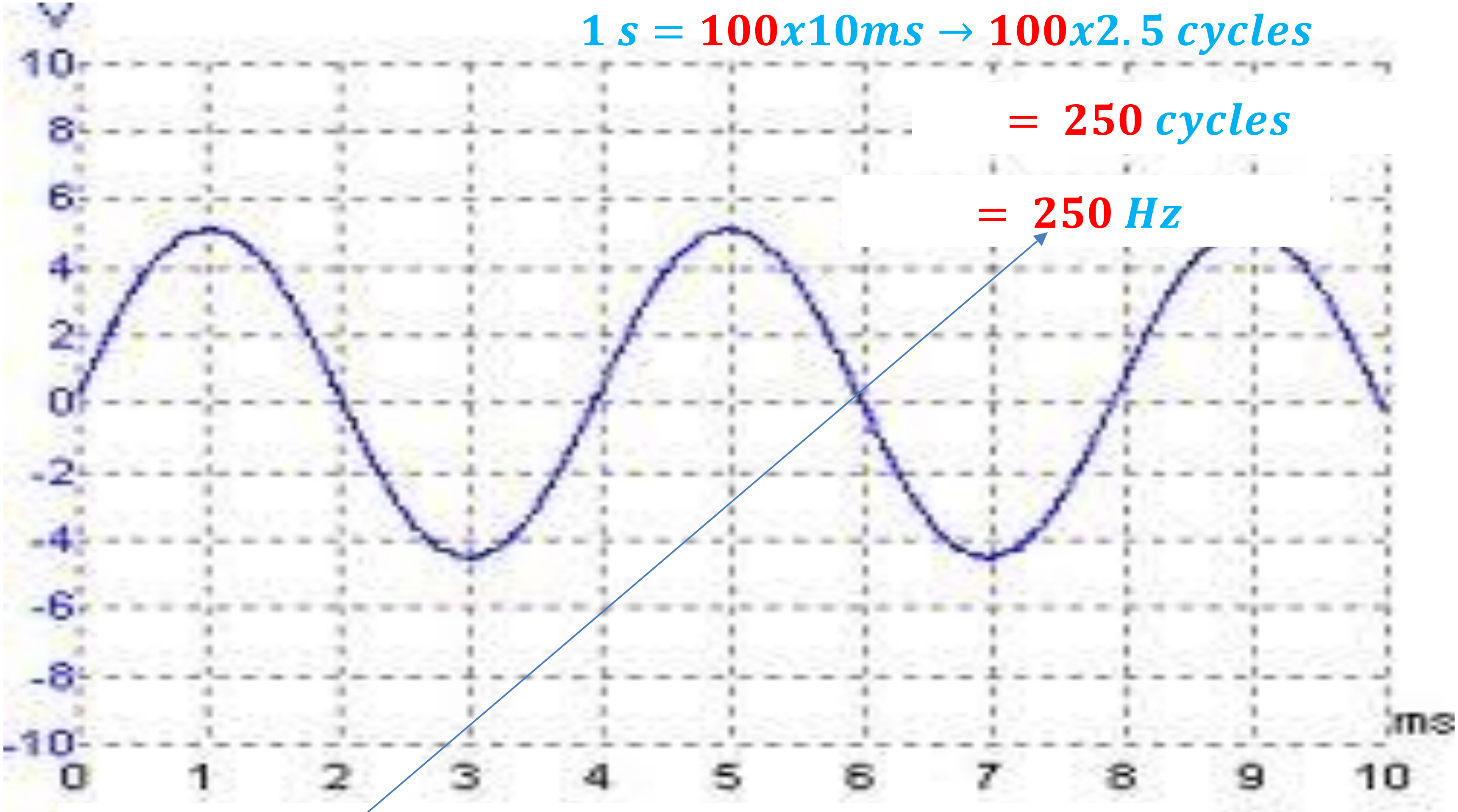
Frequency (f) =

$$10\ ms \rightarrow 2.5\ cycles$$

$$1\ s = 100x10ms \rightarrow 100x2.5\ cycles$$

$$= 250\ cycles$$

$$= 250\ Hz$$



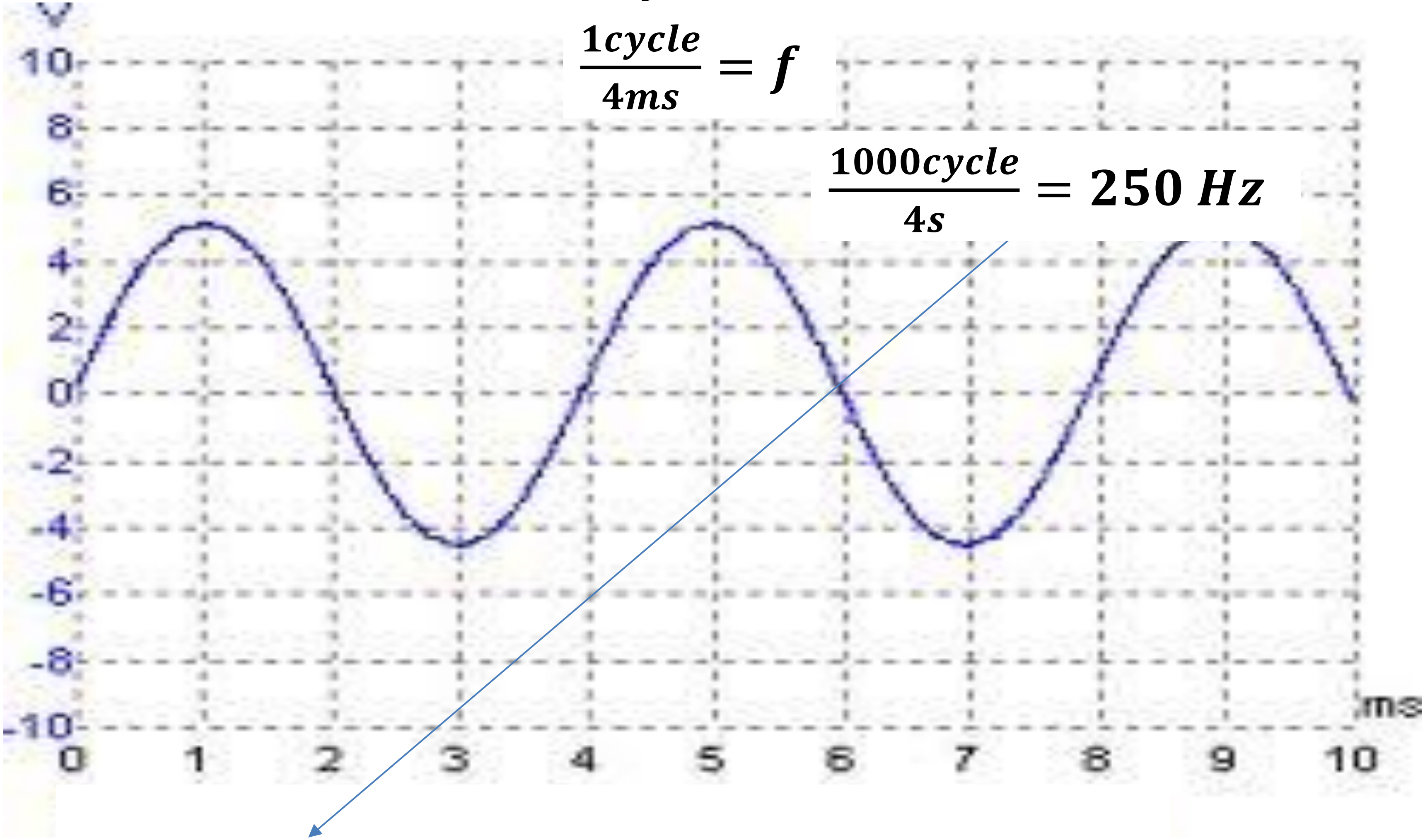
Frequency (f) is rate of change of signal or number of cycles per second.

Unit : Hertz (Hz)

$$1\ cycle = 4ms$$

$$\frac{1cycle}{4ms} = f$$

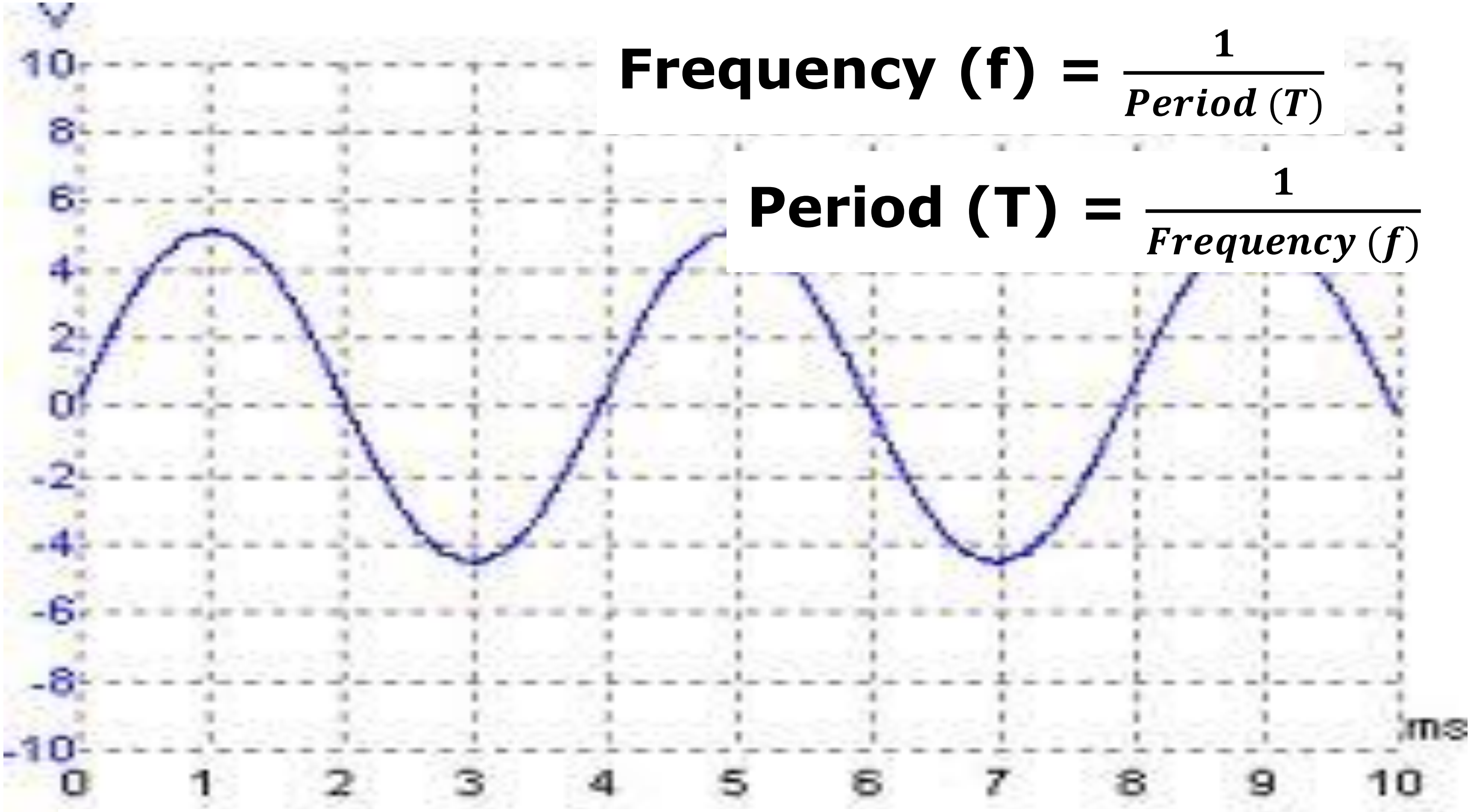
$$\frac{1000cycle}{4s} = 250\ Hz$$



Frequency (f) is rate of change of signal or number of cycles per second.

Unit : Hertz (Hz)

$$1\ cycle\ signal\ (in\ second) = Period\ (T)$$



Frequency (f) $= \dfrac{1}{Period\ (T)}$

Period (T) $= \dfrac{1}{Frequency\ (f)}$

Frequency (f) is rate of change of signal or number of cycles per second.

Unit : Hertz (Hz)

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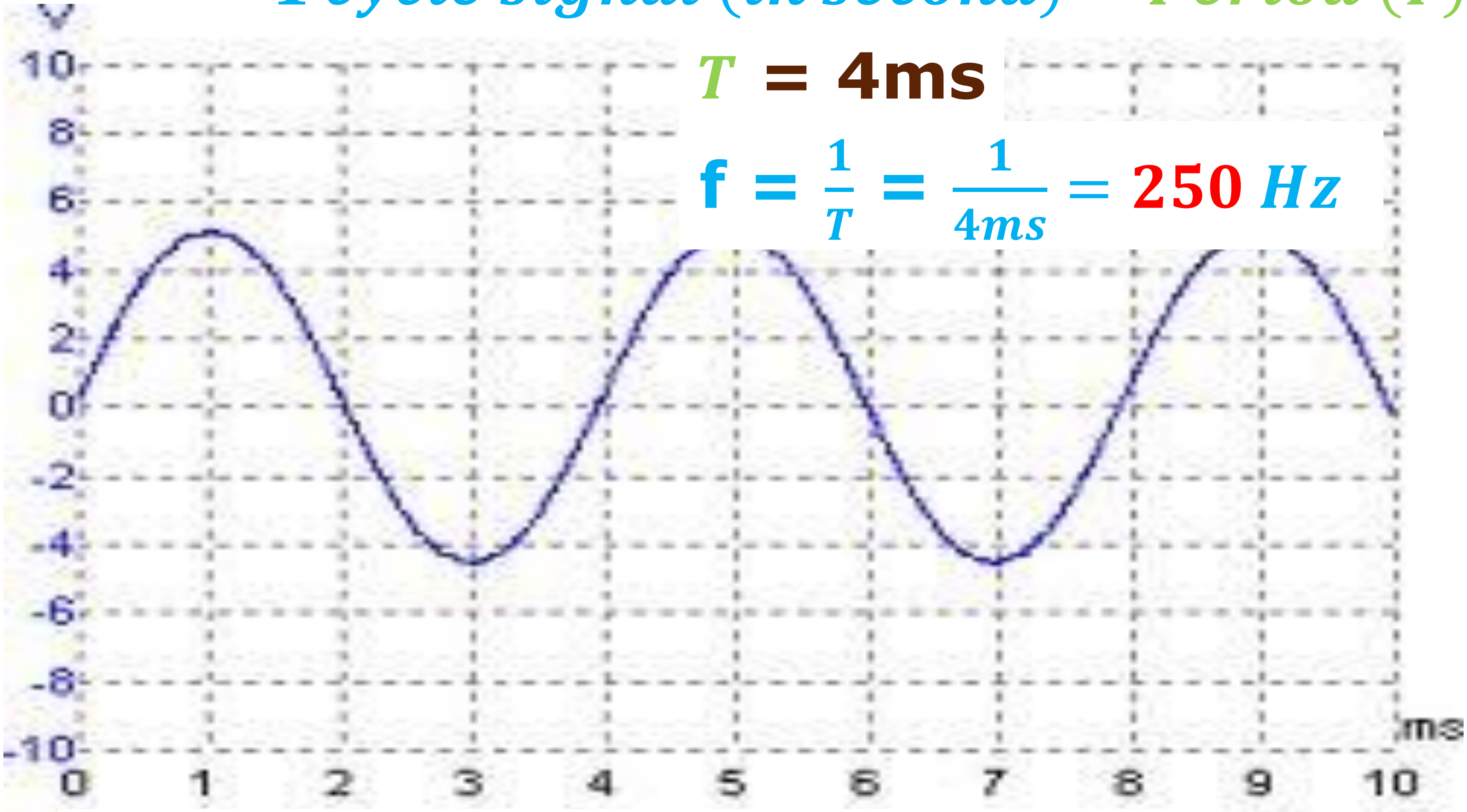
$$1\ cycle\ signal\ (in\ second) = Period\ (T)$$



$$T = 4\text{ms}$$

$$f = \frac{1}{T} = \frac{1}{4ms} = 250\ Hz$$

Frequency (f) is rate of change of signal or number of cycles per second.

Unit : Hertz (Hz)

Recall….

We know

c = speed of light

$= 3\,x\,10^{8}$ **m/s**

10ms → 10ms x $3\,x\,10^{8}$ **m/s**

λ = $(10\,x\,10^{-3}\ s)\,x\,(3\,x\,10^{8}$ **m/s)**

λ = $30\,x\,10^{5}$ **m**

λ = $3\,x\,10^{6}$ **m**

1 cycle of signal (in meter) = Wavelength (λ)

$1\ cycle\ signal\ (in\ second) = Period\ (T)$

λ $=\ T$ **x c**

$$\lambda = \frac{1}{f}\,x\,c = \frac{c}{f}$$

frequency ←→ wavelength

$f = c/\lambda$, or $\lambda = c/f$;

where c = speed of light.

$$\lambda_{meter} = \frac{3x10^8}{f_{Hz}} = \frac{3x10^5}{f_{kHz}} = \frac{300}{f_{MHz}} = \frac{0.3}{f_{GHz}}$$

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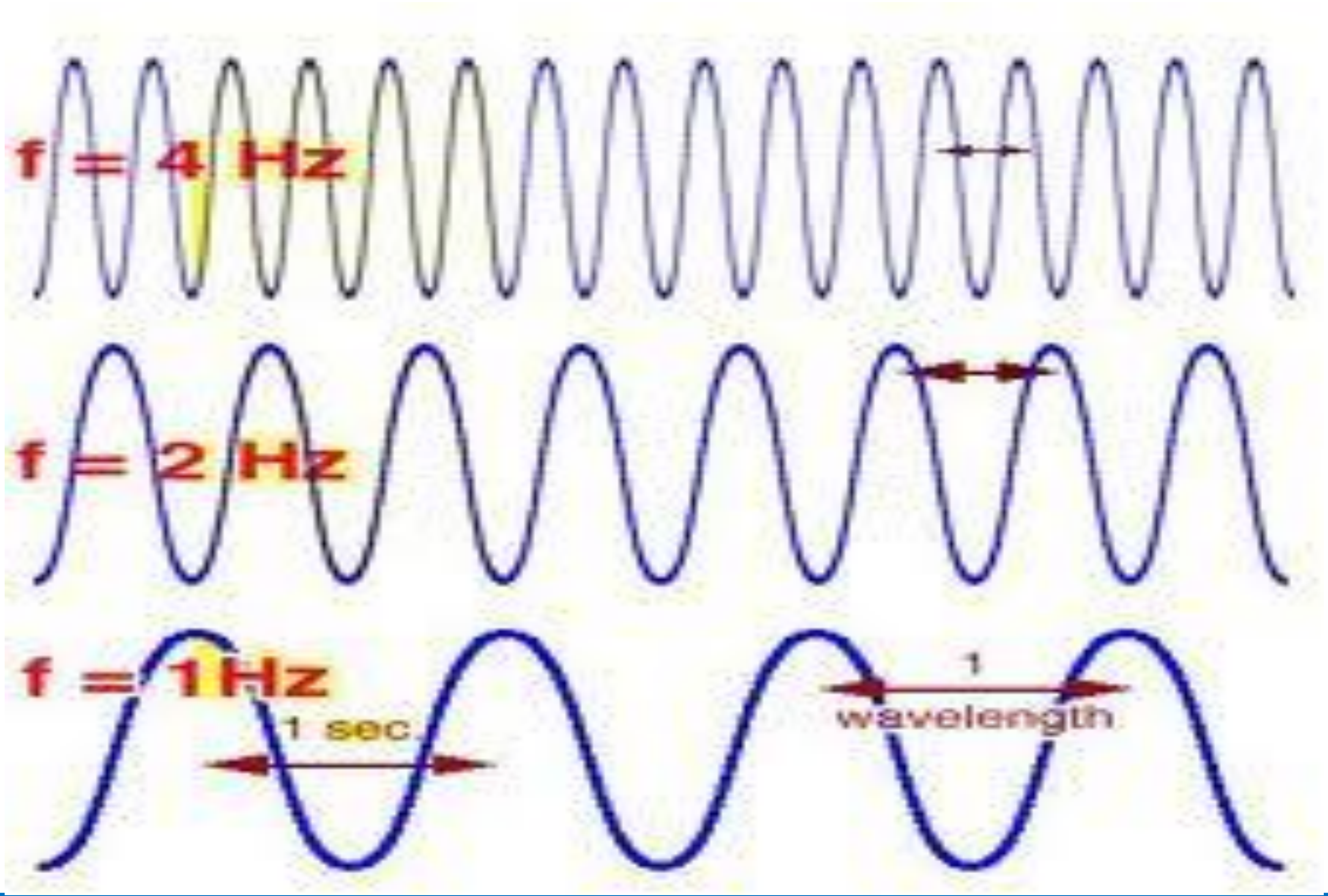
Exercise 1

Sinar FM work at 93 MHz.
What's the wavelength.

Low and High Frequency = longer and shorter wavelength



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Now..,,

we go to Chapter 1 part 2

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Chapter 1: Introduction

part 2

FREQUENCY SPECTRUM

It consists of all frequencies contained in the waveform and their respective amplitude in the frequency domain.

Philosophy;
Need to assign/define/distribute the frequency for respective purpose to avoid overlap

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Wide of road is limited

Philosophy;
Need to assign the lanes for respective vehicles

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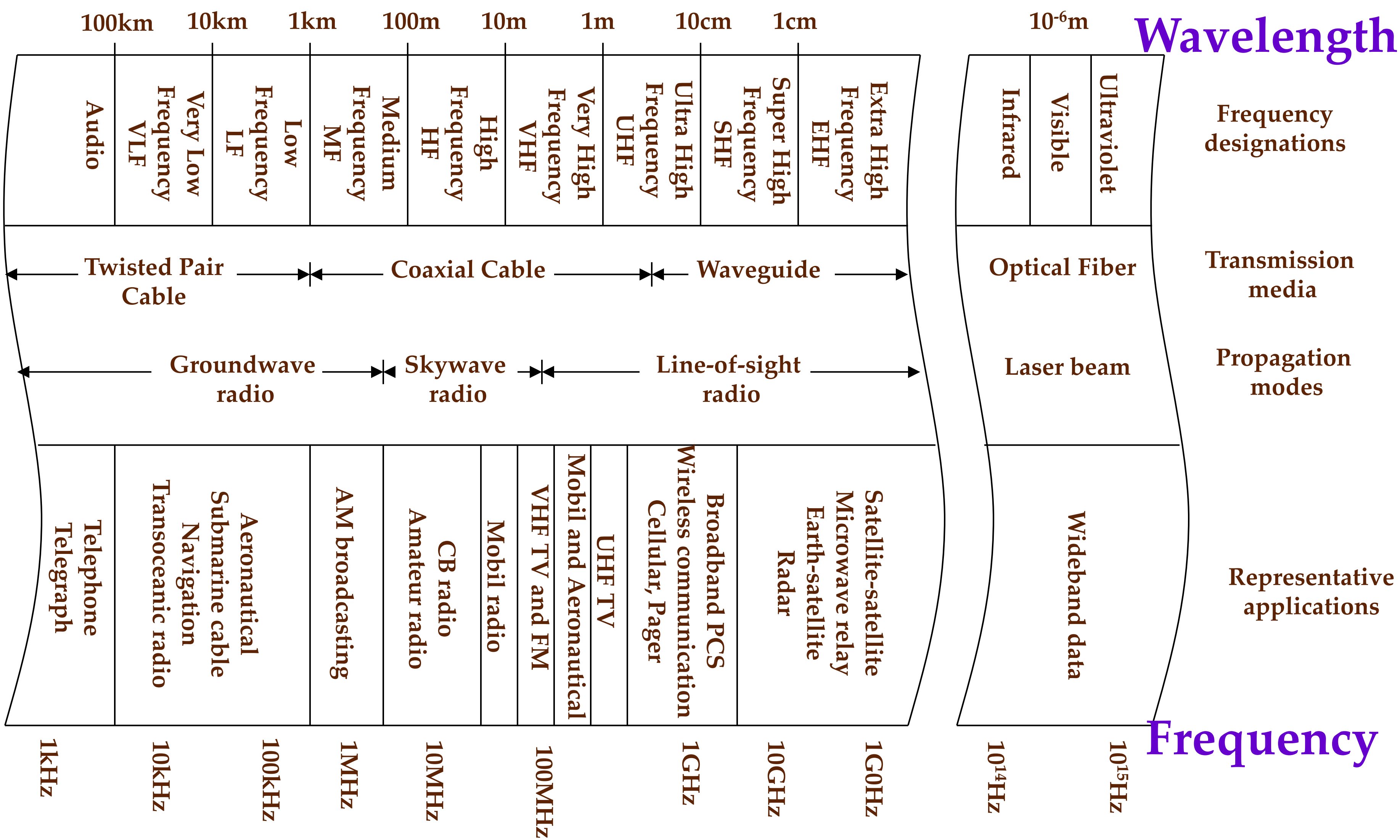
Lane is limited

Philosophy;
only one vehicle in the one lane at a time

Frequency Spectrum

	Very Low Frequency VLF	Medium Frequency MF	Extra High Frequency EHF
Wavelength	?	?	?
application	Telephone Telegraph	VHF TV and FM	Satellite-satellite Microwave relay Earth-satellite Radar
Frequency	1kHz	100MHz	10^{15}Hz

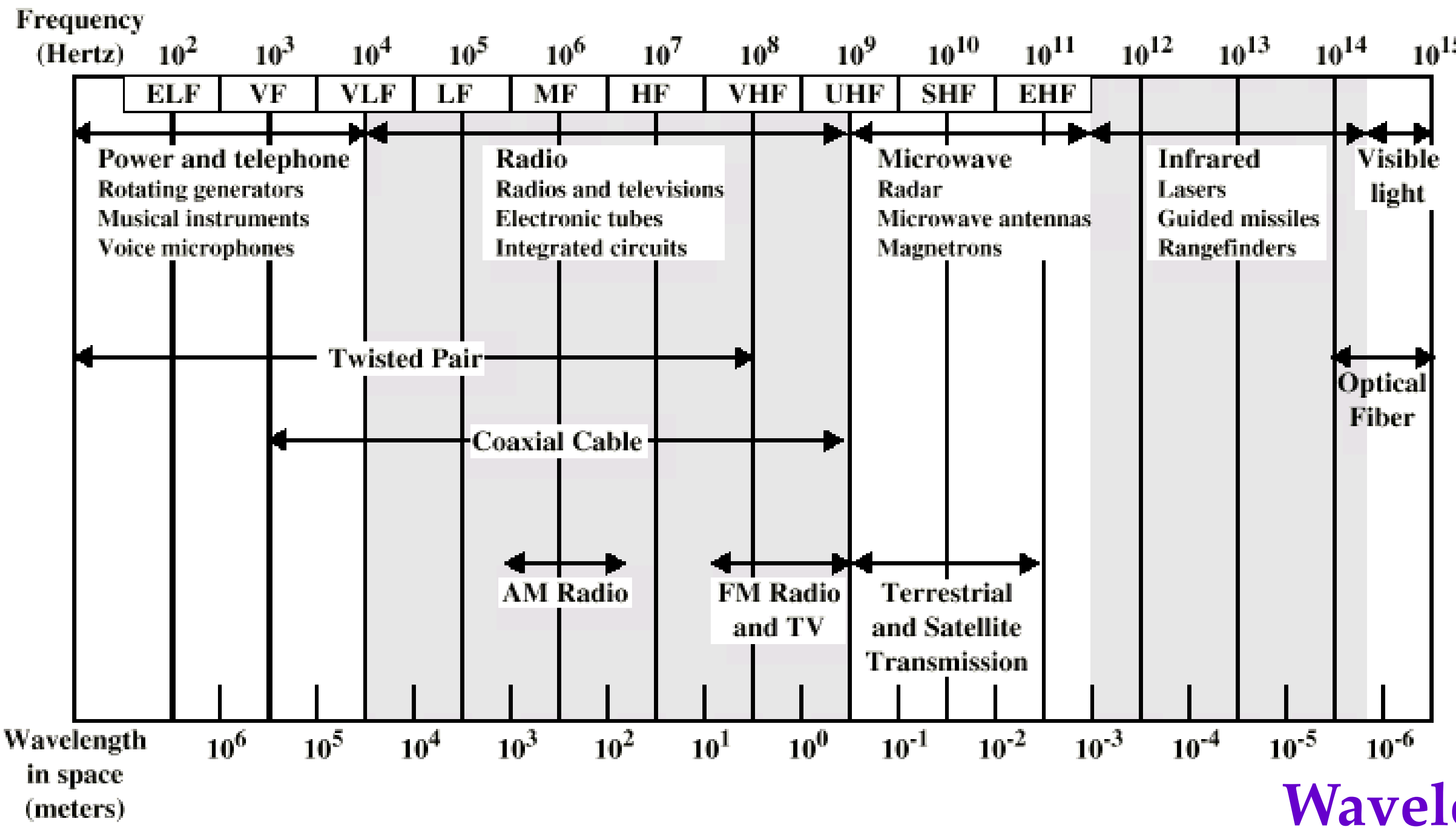
Frequency Spectrum



Another graph

Spectrum

Frequency



Wavelength

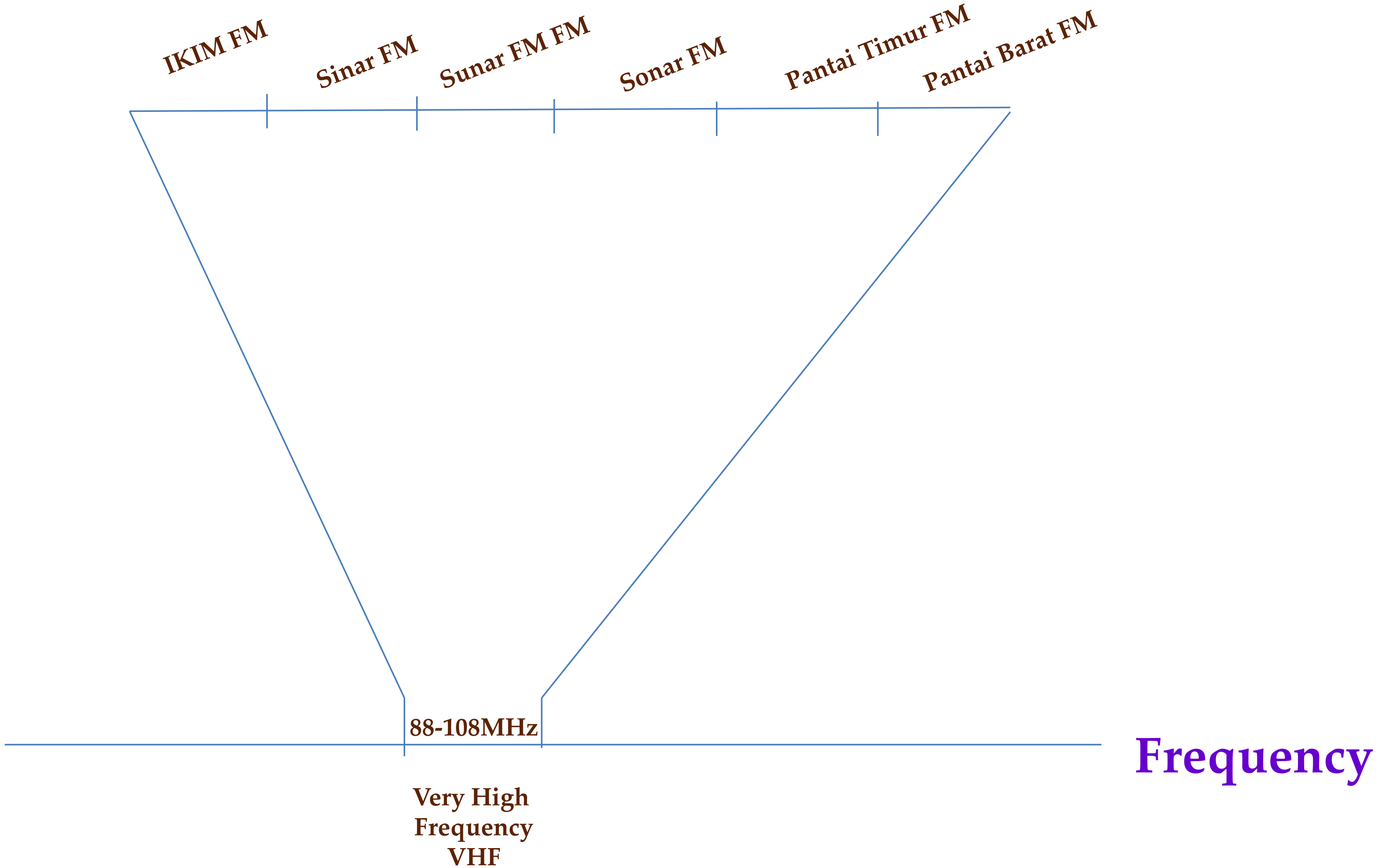
ELF = Extremely low frequency
VF = Voice frequency
VLF = Very low frequency
LF = Low frequency

MF = Medium frequency
HF = High frequency
VHF = Very high frequency

UHF = Ultrahigh frequency
SHF = Superhigh frequency
EHF = Extremely high frequency

FM Broadcasting

Spectrum is limited. So, need to assign/define/distribute the specific frequency for respective purpose to avoid overlap



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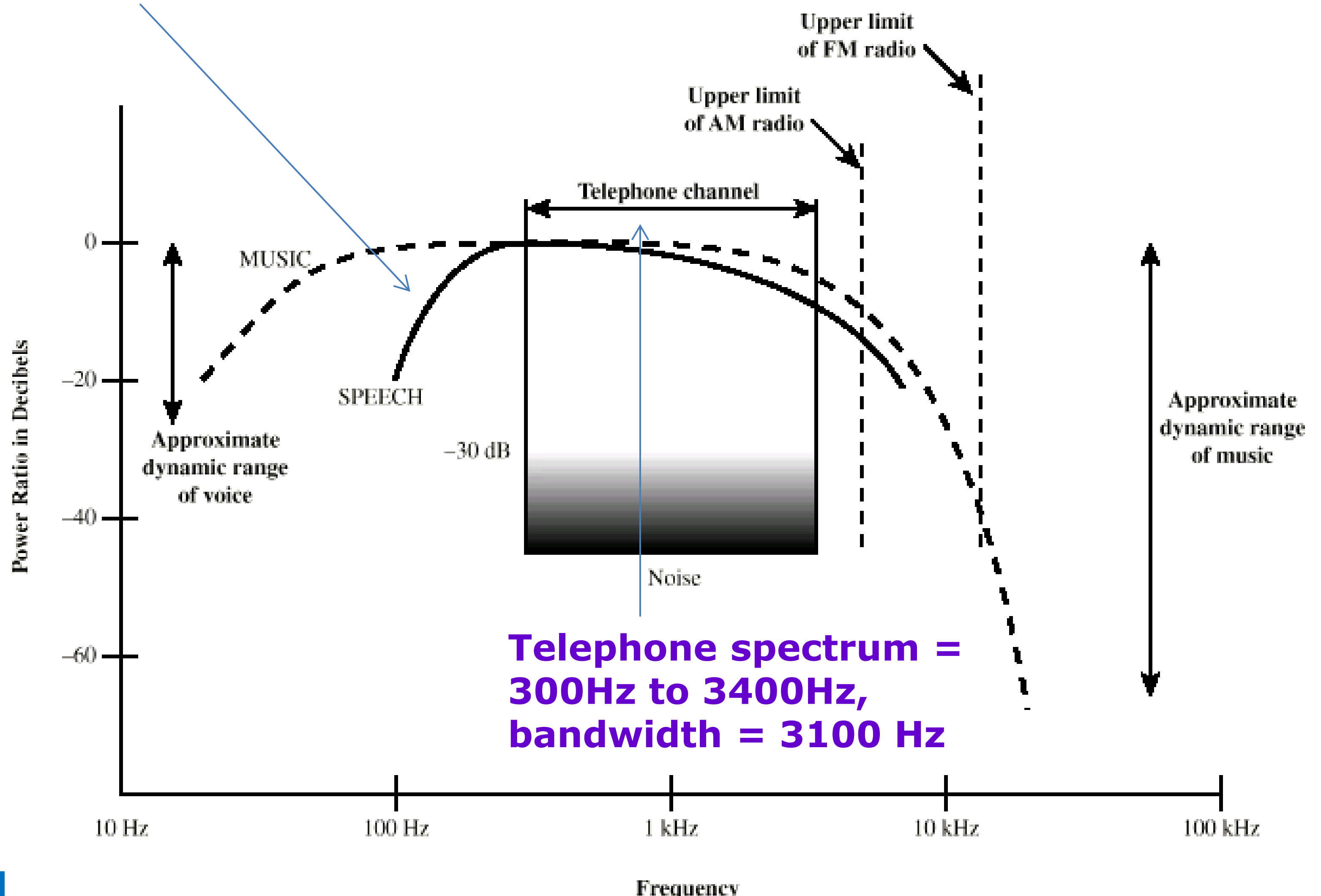
BANDWIDTH

It is the difference between the highest frequencies and the lowest frequencies of the input signal frequencies.

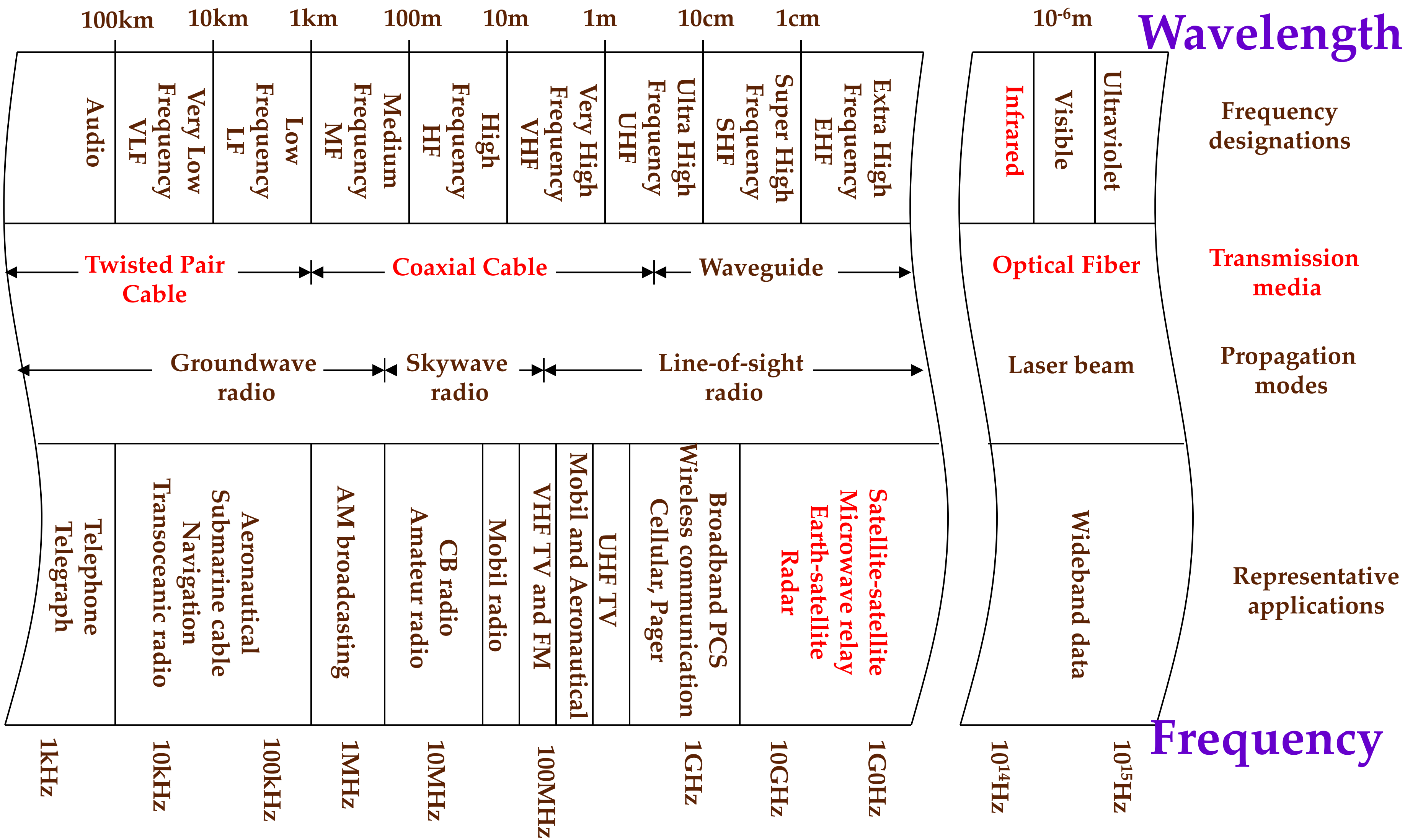
Acoustic Spectrum (Analog)

Speech spectrum = 100Hz to 7kHz, bandwidth = 6900 Hz



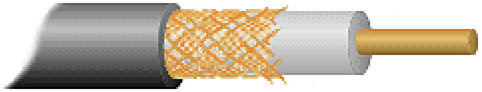
Telephone spectrum = 300Hz to 3400Hz, bandwidth = 3100 Hz

Frequency & Transmission Media

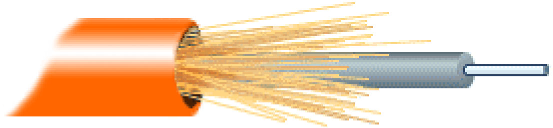


Transmission Medium (Guided)

- *Twisted pair*
  - Unshielded Twisted Pair (UTP)
  - Shielded Twisted Pair (STP)
- *Coaxial*



- *Fiber Optic*

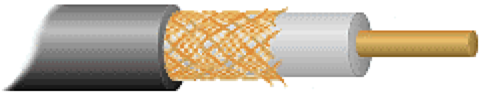


Transmission Medium (Unguided)

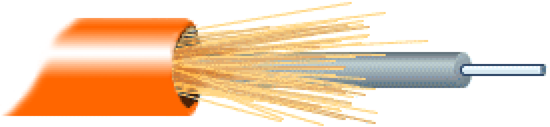
- infra red
- microwave
- Satellite

Transmission Medium (Guided)

- *Twisted pair*
  - UTP
  - STP
- *Coaxial*



- *Fiber Optic*



	work at	
	frequency	wavelength
Twisted pair		
Coaxial		
Fiber optic		
Infrared		
Microwave		
Satellite		

Transmission Medium (Unguided)

- infra red
- microwave
- Satellite

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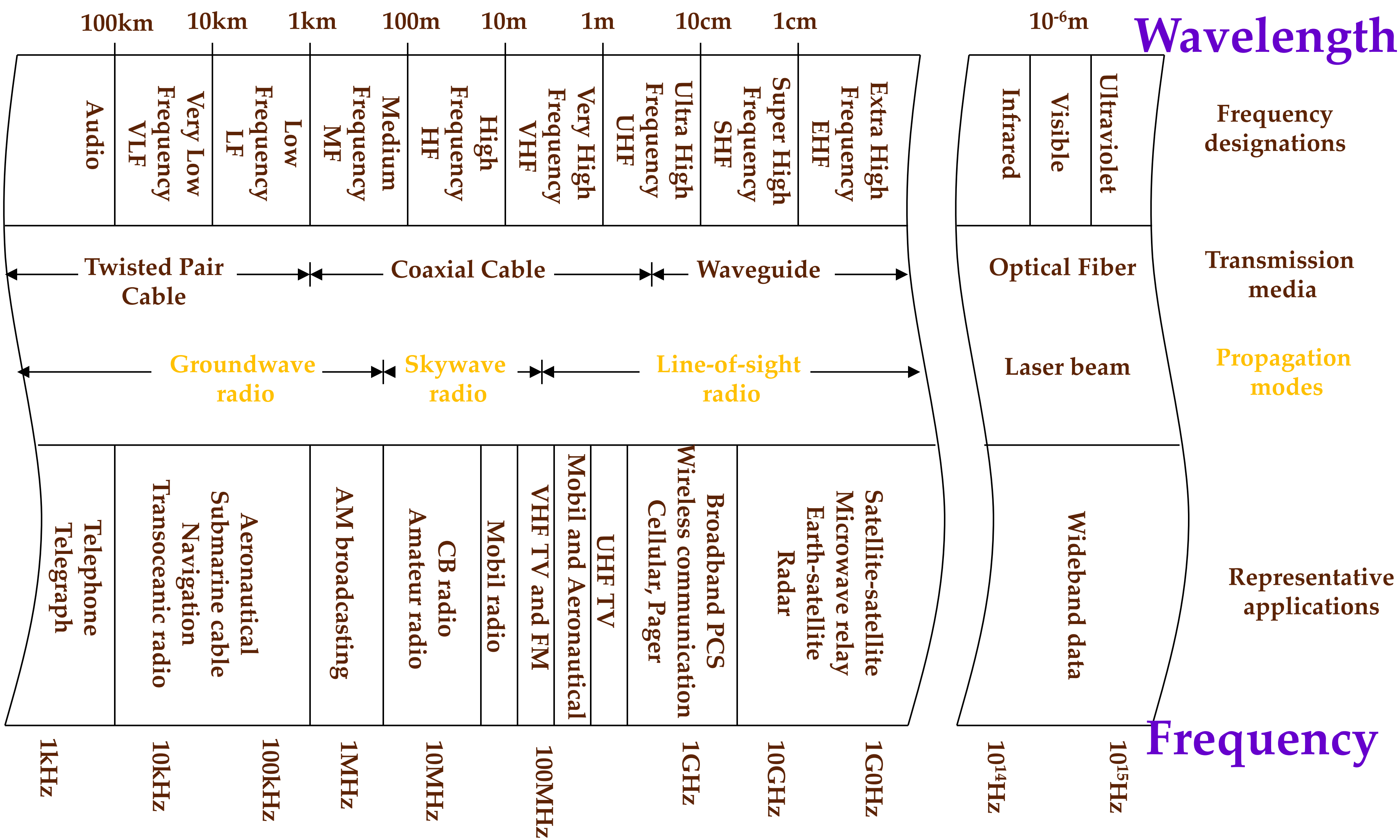
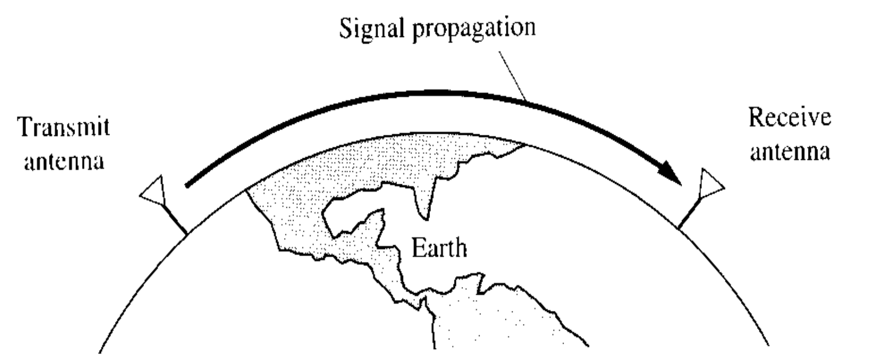
Frequency & Propagation Modes



Propagation Modes

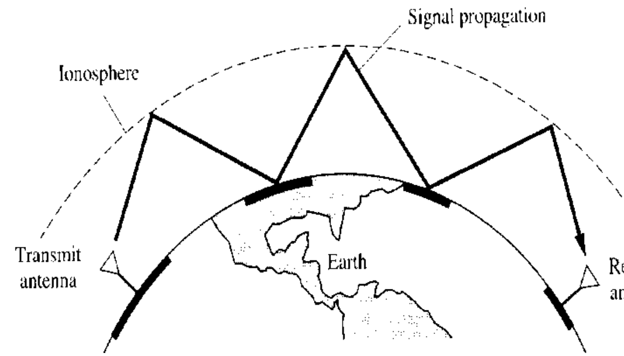
A signal can be propagated in 3 ways:

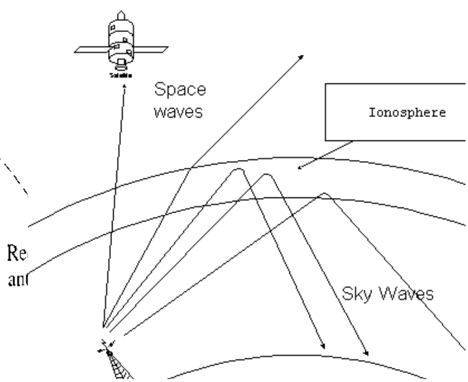
1. **Ground-Wave Propagation**
   Frequency < 2 MHz



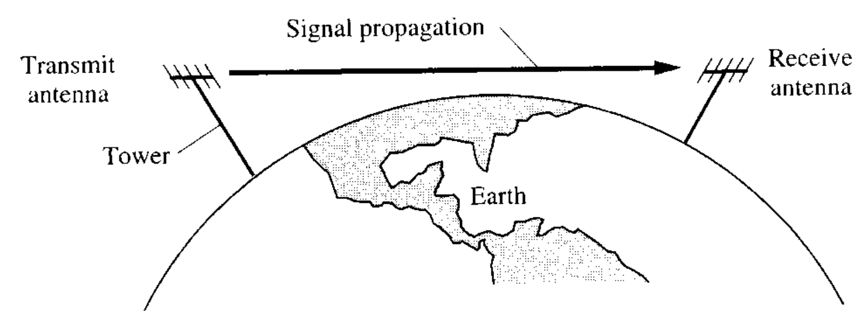
(a) Ground–Wave Propagation (Below 2 MHz)

2. **Sky-Wave Propagation**
   Frequency = 2 MHz - 30 MHz





3. **Line-of-Sight Propagation**
   Frequency > 30 MHz



(c) Line-of-Sight (LOS) Propagation (Above 30 MHz)

Types of Transmission

- **Simplex**

  One way transmission

- **Half-Duplex**

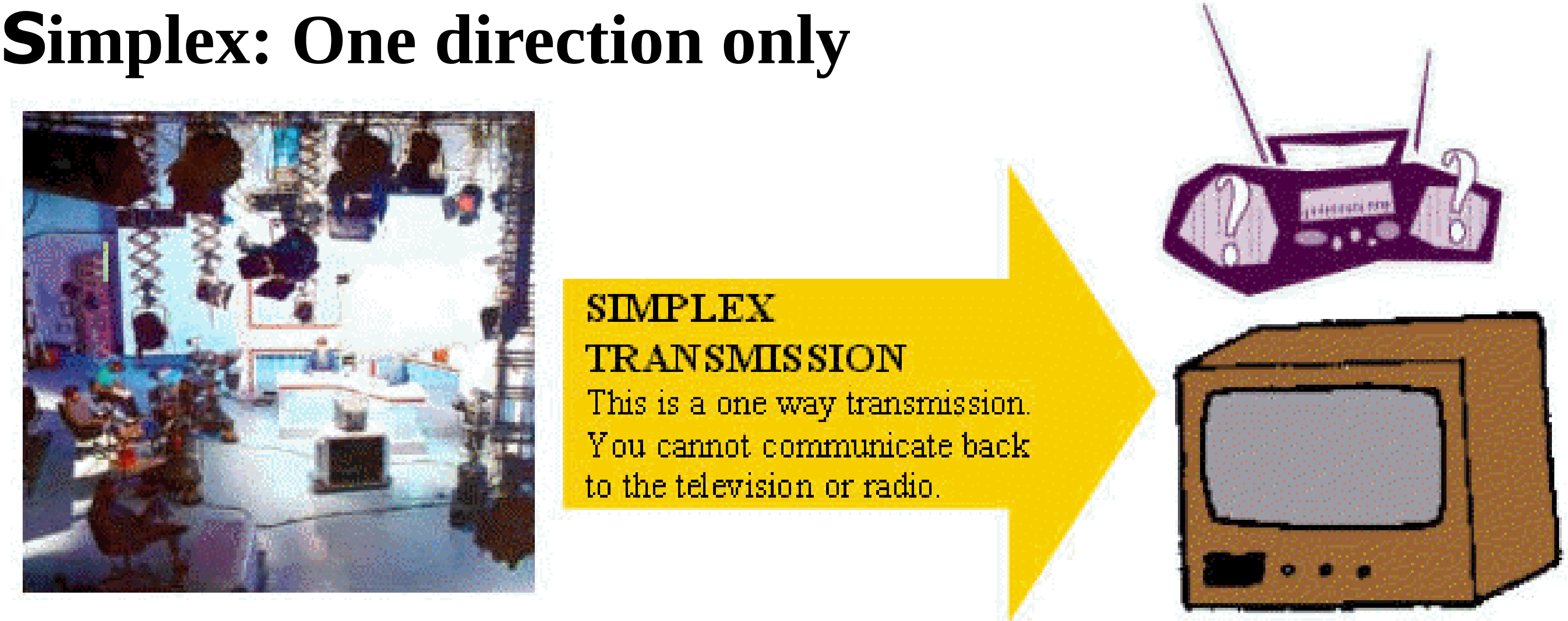
  Two way transmission but only one user can transmit the signal at one time.

- **Full-Duplex**

  Two way transmission, both users can transmit the signal at the same time.

Simplex

Simplex: One direction only



Half-Duplex

Both directions,
but only one direction at a time

Full-Duplex

send and receive both directions at once

Sir, our students are very smart.

Why topics that delivered in this subject are very simple and easy ????

OOO…OO…O…..
Please wait ……

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Refreshing (again).......

What is decibel ?

Distance unit:

Meter-deci-centi-mili-micro

1 Meter = 10 decimeter
1 Meter = 100 centimeter
1 Meter = 1000 milimeter

1 Bel = 10 decibel

What is decibel ?

decibel is a relative unit of measurement

relative = ... less/more compared to ....

Example;

Fathimah is more beautiful than her grandmother
Output voltage is lower than input voltage
Power output is higher than power input

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1 Bel = 10 decibel

Decibel

- decibel frequently used in electronic communications to describe power gain or loss
- This equation is commonly referred to as the power ratio form for dB.

$$dB = 10 \log_{10} \frac{P_2}{P_1}$$

P_1 = input power level
P_2= output power level

The decibel is a measure of the difference in two power levels.

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Decibel

$$P = V.I = V.\frac{V}{R} = V^2$$

R constant

$$dB = 10 \log_{10} \frac{P_2}{P_1}$$

$$dB = 10\log_{10} \frac{V_2^2}{V_1^2}$$

$$dB = 10 \log_{10} \left(\frac{V_2}{V_1}\right)^2$$

$$dB = 20 \log_{10} \frac{V_2}{V_1}$$

The decibel is a measure of the difference in two power levels.

- To calculate the ratio of 1 kW (one kilowatt, or 1000 watts) to 1 W in decibels, use the formula

$$G_{\mathrm{dB}} = 10\log_{10}\left(\frac{1000\mathrm{W}}{1\mathrm{W}}\right) = 30\mathrm{dB}$$

- To calculate the ratio of 1 mW (one milliwatt) to 10 W in decibels, use the formula

$$G_{\mathrm{dB}} = 10\log_{10}\left(\frac{.001\mathrm{W}}{10\mathrm{W}}\right) = -40\mathrm{dB}$$

Decibel

decibel is used frequently in electronic communications to describe power gain or loss

What is GAIN ?

What is LOSS ?

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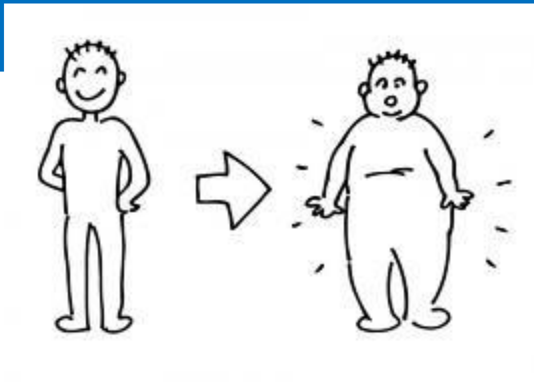
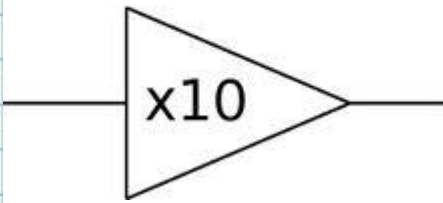




Growth, increase

Amplifiers can be used to provide a **gain** in signal strength

Gain;

$$G_{dB} = 10 \times \log_{10} (P_{out}/P_{in})$$

P_{in} = P_1 = input power level
P_{out} = P_2 = output power level

Gain, Loss

Gain is usually as a positive value,

if the result is negative it is considered as a negative gain or (positive) loss.

Remember

Gain → $G_{dB} = 10 \times \log_{10} (P_{out}/P_{in})$

Loss → $L_{dB} = - 10 \times \log_{10} (P_{out}/P_{in})$

$L_{dB} = 10 \times \log_{10} (P_{in}/P_{out})$

Exercise 1a

A signal with a power level of 10 mW is inserted onto a transmission line and the measured power some distance away is 5 mW. Calculate the loss!

Answer;

$L_{dB} = ?$

Example;

A signal with a power level of 10 mW is inserted onto a transmission line and the measured power some distance away is 5 mW. Calculate the loss!

Answer;

Loss → $L_{dB} = 10 \times \log_{10} (P_{in}/P_{out})$

$L_{dB} = 10 \times \log_{10} (10/5)$

$L_{dB} = 10 \times (0.3) = 3$ dB

Exercise 1b

P_{in} = 10 mW, P_{out} = 5 mW → L_{dB} = 3 dB

P_{in} = 500 mW, P_{out} = 250 mW → L_{dB} = ?

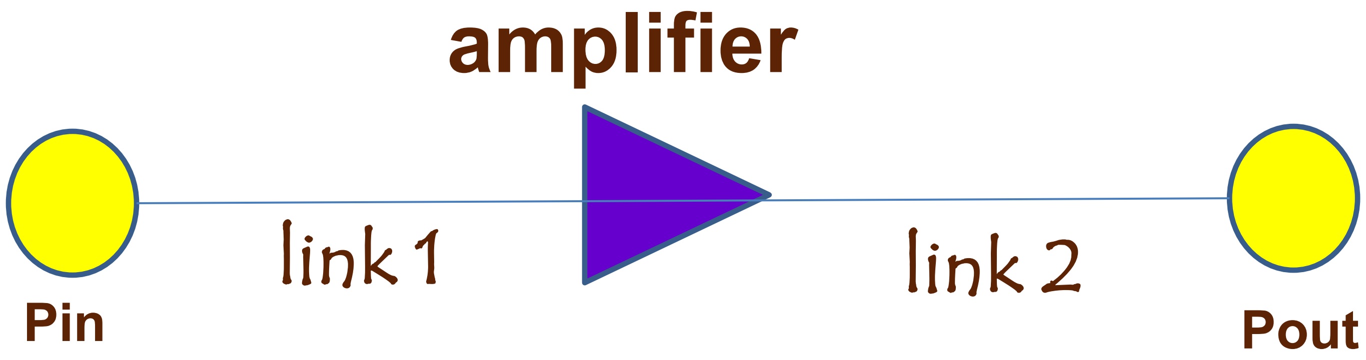
3 dB

To find the power ratio corresponding to a 3 dB change in level, use the formula

$$G = 10^{\frac{3}{10}} \times 1 = 1.99526... \approx 2$$

Gain = 3dB → Power is increase 2x

Gain of System



The overall gain for a point-to-point system can be calculated by adding component dB values.

System Gain = loss link 1 + gain amplifier + loss link 2

Exercise 2

Transmission line consists of link 1 and link 2 which losses are 12 dB and 10 dB respectively.

Amplifier used to increase 35 dB gain in the between of link 1 and link 2.

If 4mW input power level is used, calculate output power!

Answer;

$P_{out} = ?$

Answer;

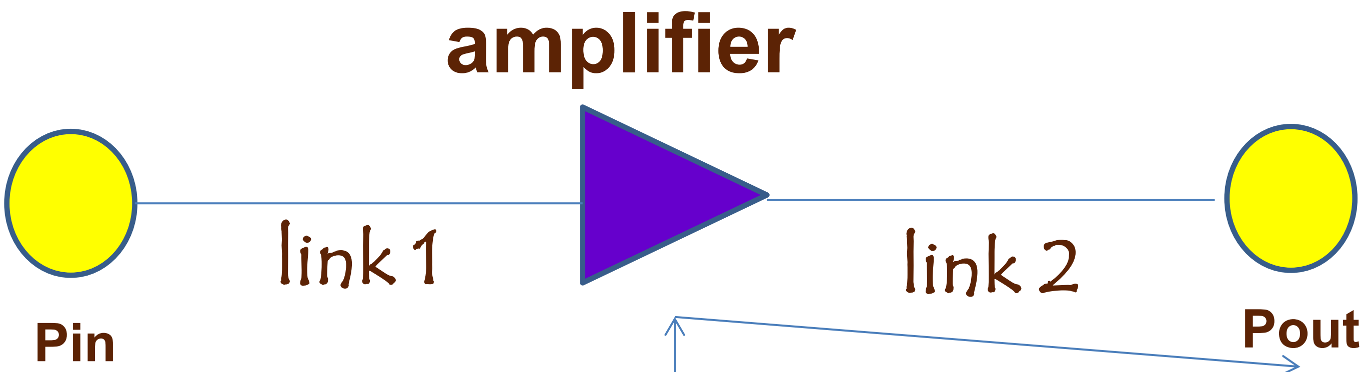
gain= - loss

System Gain = gain link 1 + gain amplifier + gain link 2

= -12 dB + 35 dB + -10 dB

= 13 dB

Input power level = (Pin) = 4 mW.



Output power = P_{out} = ?

System Gain = 13 dB, Pin = 4 mW

$G_{dB} = 13_{dB}$

$13 = 10 \log_{10} (P_{out}/P_{in})$

$13 =10 \log_{10} (P_{out}/4mW)$

$1.3 = \log_{10} (P_{out}/4mW)$

$10^{\mathbf{1.3}} = P_{out}/4mW$

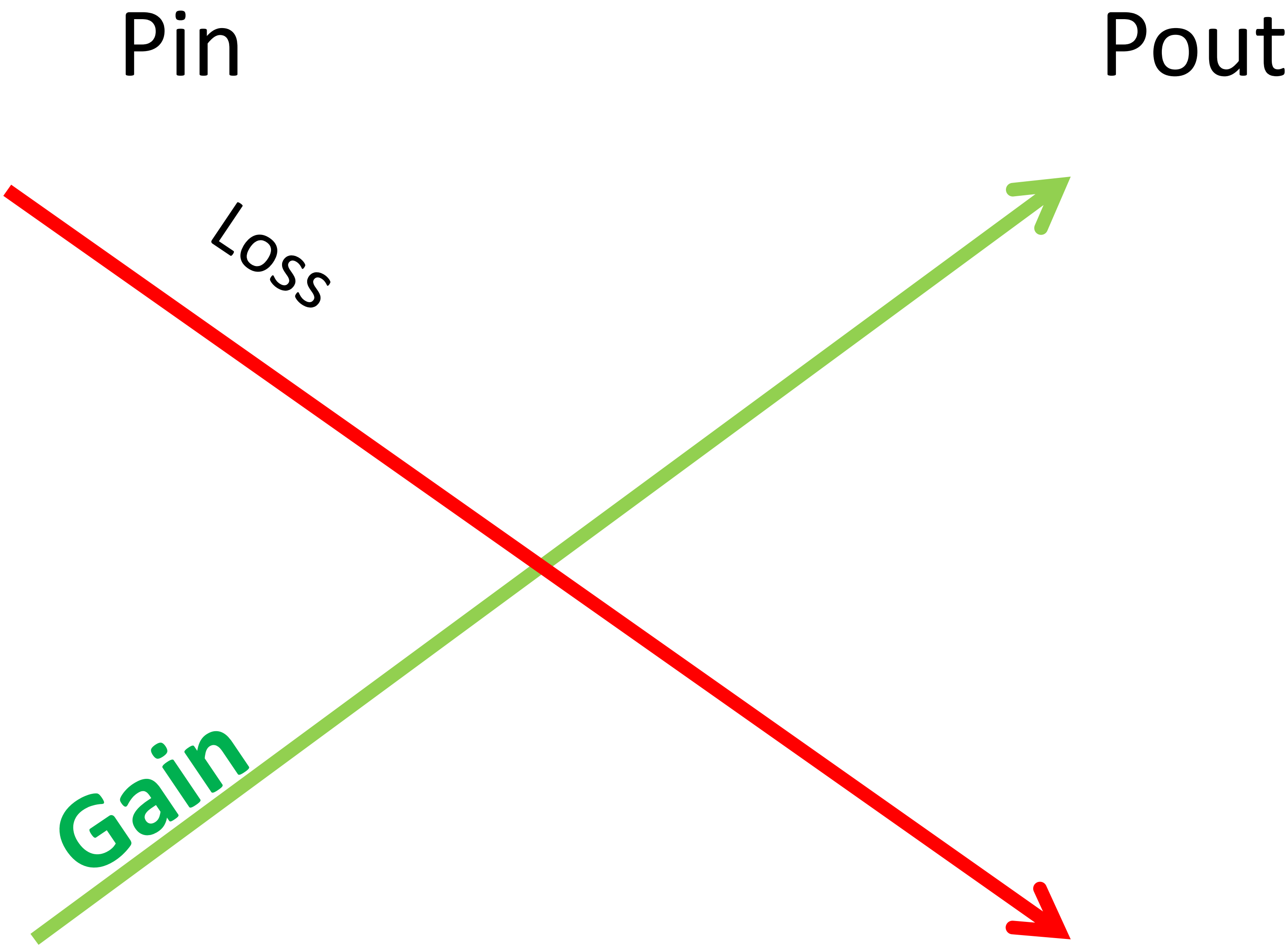
$P_{out} = 79.8$ mW

Exercise 3

Example;

A signal with a power level of 10 mW is received from 30 km transmission line with 1 dB/km of loss. Calculate transmitted power level in the transmitter.

Answer;


Pin
Pout
Loss
Gain

Absolute Power Levels (1 W as a reference)

Example;

1 W is equivalent to

$$10log\left(\frac{1}{1}\right) = 10log(10)^{0} = \mathbf{10x0 = 0\ dBW}$$

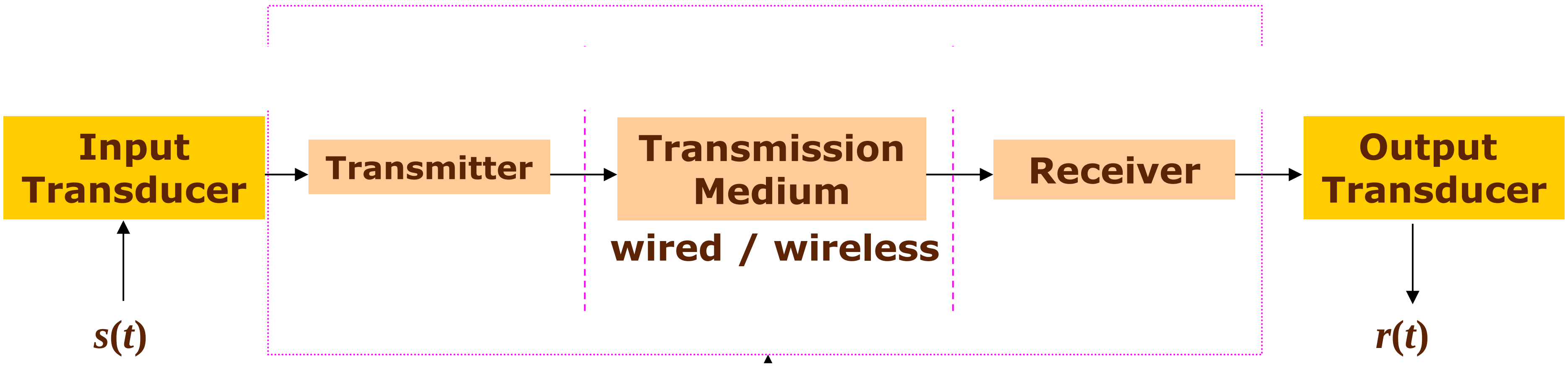
1000 W is equivalent to

$$10log\left(\frac{1000}{1}\right) = 10log(10)^{3} = \mathbf{10x3 = 30\ dBW}$$

1 mW is equivalent to

$$10log\left(\frac{0.001}{1}\right) = 10log(10)^{-3} = \mathbf{10x(-3) = -30\ dBW}$$

Basic Communication System



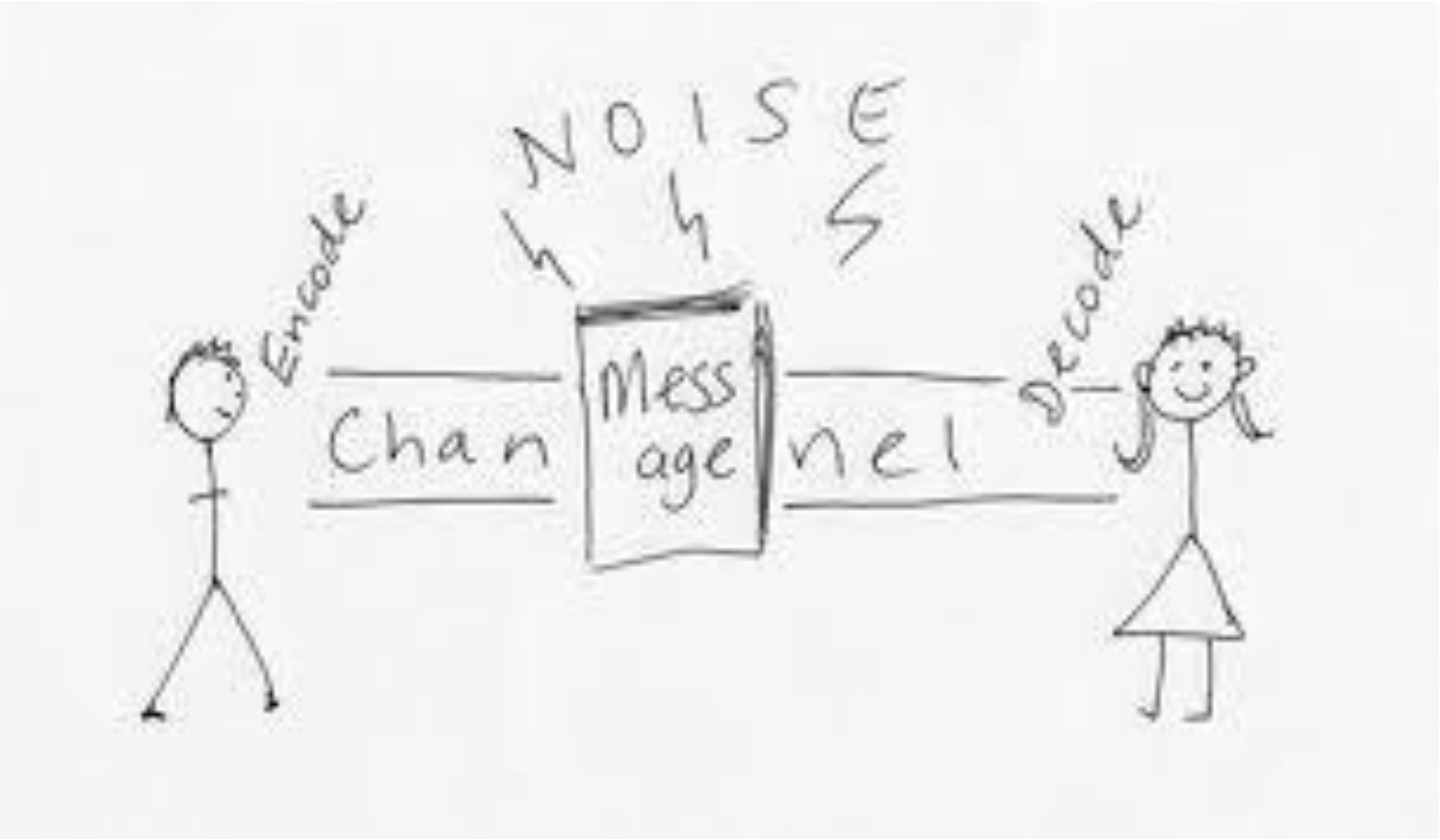
$s(t)$ – Input signal at sending end; audio, video, image, data etc.
$r(t)$ – Output signal at receiving end.

$m_{tx}(t)$ – Modulating signal; input signal that has been converted to electrical signal.
$p_{tx}(t)$ – Modulated signal transmit by the transmitter.
$p_{rx}(t)$ – Modulated signal receive by the receiver.
$m_{rx}(t)$ – Modulating signal at the receiver.

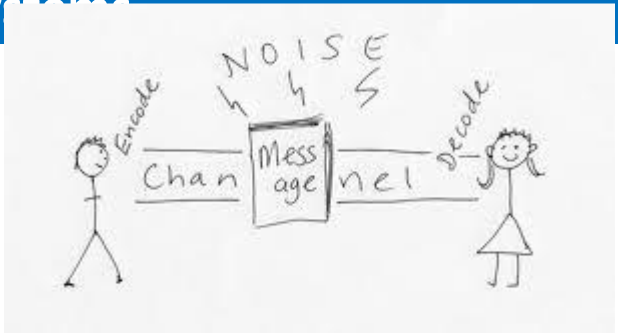
$n(t)$ – Noise signal.

NOISE

What is noise ?



Noise



Additional unwanted/undesired signals inserted between transmission and reception.

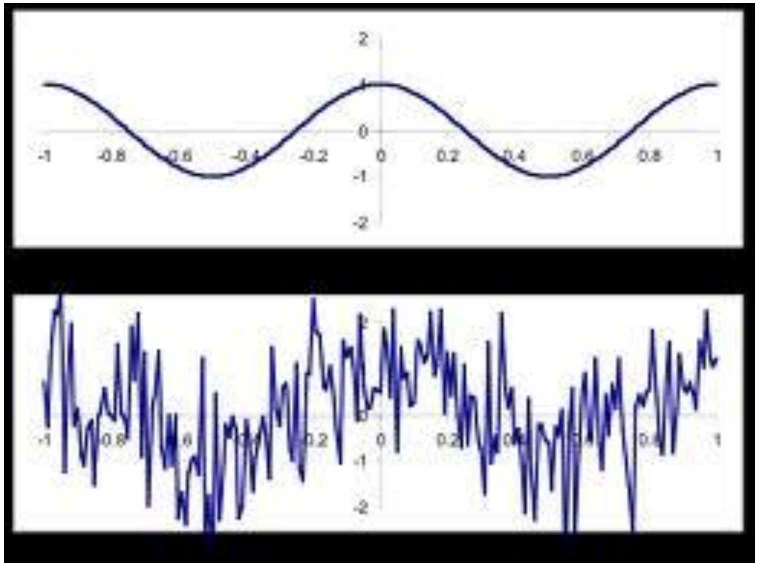
Noise categories;

1. **Thermal noise**
2. **Intermodulation noise**
3. **Crosstalk**
4. **Impulse noise**

Thermal Noise

- Thermal noise is due to thermal agitation of electrons.
- Present in all electronic devices and transmission media and a function of temperature.
- Uniformly distributed across the bandwidths and often referred as white noise.
- Can not to be eliminated
- Significant for satellite communication.

Thermal Noise



White noise draws its name from white light in which the power spectral density of the light is distributed over the visible band in such a way that the eye's three color receptors (cones) are approximately equally stimulated.

Thermal Noise

$N_o = kT$ (W/Hz)

No = **noise power density** in watts per 1 Hz of bandwidth

k = Boltzmann's constant = 1.38×10^{-23} J/K

T = temperature in kelvins (absolute temperature)

Thermal noise in B Hz bandwidth;

B= noise power bandwidth in hertz

$N = kTB$ **(dBW)**

$$N = 10 \log_{10} k + 10 \log_{10} T + 10 \log_{10} B$$

$$N = -228.6 \text{ dBW} + 10 \log_{10} T + 10 \log_{10} B$$

Thermal Noise

Example 1

Room temperature is usually specified as T = 17^{0}C or 290 K.

Thermal noise power density;

- $N_o = kT$
- $N_o = (1.38 \times 10^{-23}) \times 290$
- $N_o = 4 \times 10^{-21}$ W/Hz

Thermal Noise

Example 2

Given a receiver with an effective noise temperature of 294 K and a 10 MHz bandwidth, the thermal noise level at the receiver's output is .....

$N = ?$

Exercise 4

Thermal Noise

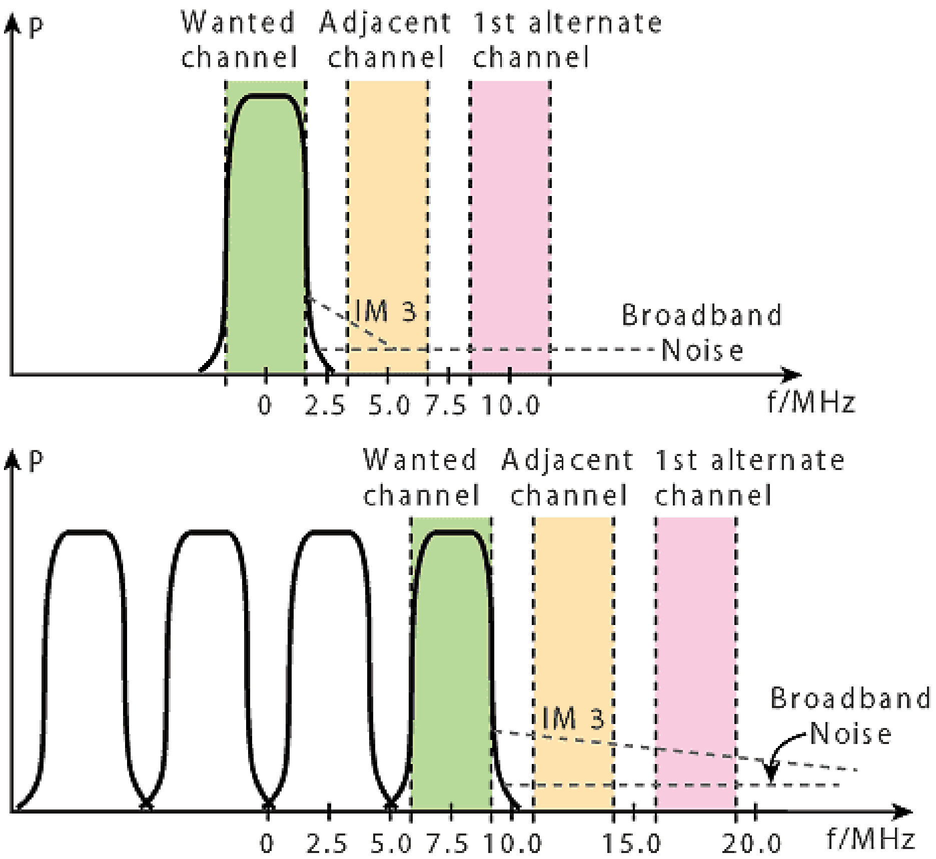
An analog signal transmitted using digital transmission for 2km distance. The media contributes 6dB/km of attenuation in the temperature of 17 degree Celcius. Calculate thermal noise level if the bandwidth is 10MHz!

Thermal Noise

An analog signal transmitted using digital transmission for 2km distance. The media contributes 6dB/km of attenuation in the temperature of 17 degree Celcius.
Calculate thermal noise level if the bandwidth is 10MHz!

$$N = kTB$$
$$N = 10 \log_{10} k + 10 \log_{10} T + 10 \log_{10} B$$
$$N = -228.601 \text{ dBW} + 10 \log_{10} 290 + 10 \log_{10} 10^{-7}$$
$$N = -228.601 + 24.62398 + 70$$
$$N = -133.977 \text{ dBW}$$

Intermodulation Noise

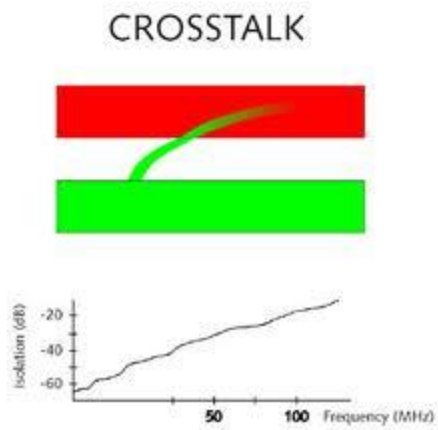


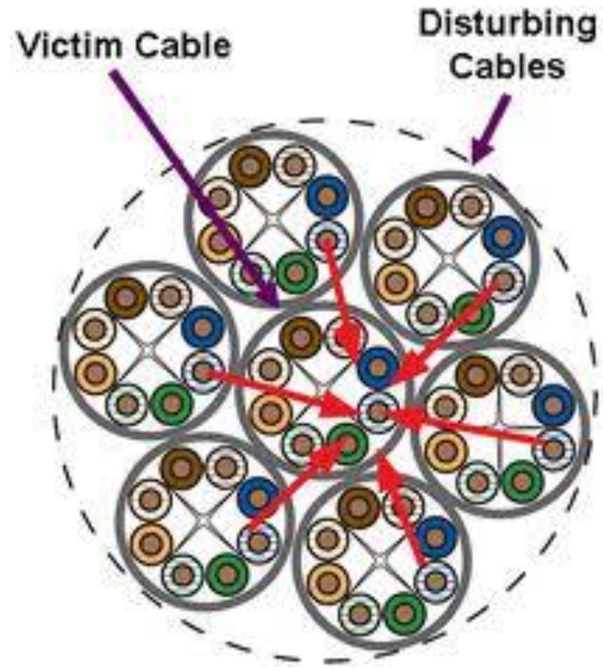
3. These illustrations show third-order intermodulation and wideband noise for a single 3GPP carrier (top) and a 3GPP four-carrier signal (bottom).

Intermodulation Noise

- Different frequencies share the same transmission medium will produce signals at a frequency that is the sum or difference of two/multiples original frequencies.
- Intermodulation noise is produced by nonlinearities in the transmitter, receiver, and/or intervening transmission medium.

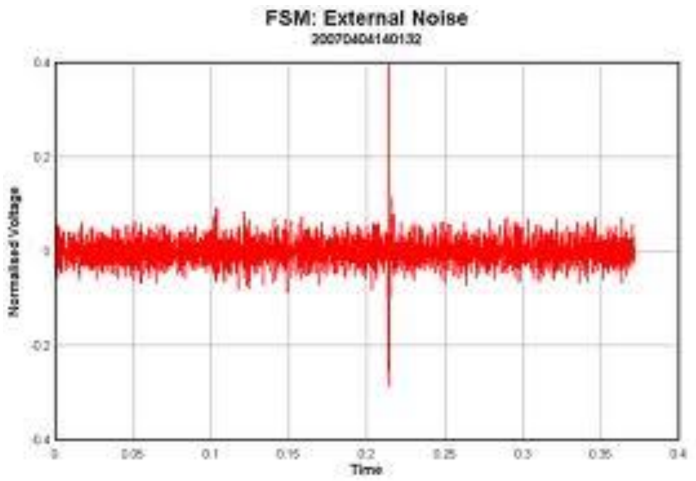
Crosstalk





- Crosstalk
  - A signal from one line is picked up by another
  - Using the telephone; hear another conversation
- Occur by electrical coupling between nearby twisted pair, coax cable, microwave carrying multiple signals.

Impulse Noise



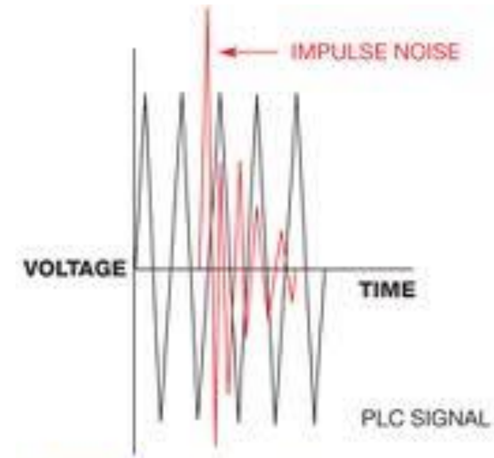


Figure 2 Impulse noise on the power line is unpredictable and can obliterate any coincident data packets.

Irregular pulses or spikes of short duration and relatively high amplitude.

It is generated from a variety causes, including external electromagnetic disturbances, such as lightning, and faults and flaws in the communication system

Chapter 1: Introduction

Already finished

1.1 Basic Communication System
1.2 Baseband and Modulated Signal
1.3 Modulation
1.4 Analog and Digital Signal
1.5 Spectrum, Bandwidth
1.6 Propagation Techniques
1.7 Noise

Go…. Go… to Chapter 2

Thank You

Go…. Go… to Chapter 2