# Module-5

Electronics Communication:
Introduction to electronic communication system, Electromagnetic Communication Spectrum band and applications, Elements of Electronic communication system; Major design parameters and primary resources of comm" system, Modes of Communication, Signal radiation and propagation Need for modulation, Introduction to Amplitude modulation and Angle Modulation.

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**Communication**: It is the basic process of exchanging information.

e.g → line telephony, Line telegraphy, radio broadcasting mobile communication, computer Communication etc..

→ The propagation of electrical signals through the communic" channel take place in the form of electromagnetic signals.

→ signals that travel through free space are called radio-frequency waves or electromagnetic waves.

→ The two resources of communication are,
- → average transmitted power
- → available channel bandwidth

As much as possible, these resources must be utilized efficiently.

→ Electromagnetic waves ~~propagat~~ propagates through the space via, → ground wave
→ sky wave

## Electromagnetic freq. Spectrum:

$$\lambda = \frac{c}{f}$$

$\lambda$ → wave length (metere)
$c$ = velocity of EM waves in free space = velocity of light
$= 3 \times 10^8$ m/s
$f$ = frequency (Hz)

e.g: Determine the wavelength of voice signal of 1 kHz broadcast radio freq. of 100 MHz and cellular phone freq. of 900 MHz.

$f = 1\,kHz$, $\lambda = \frac{3\times10^8\,m/s}{1\times10^3\,Hz} = 300\,km$

$f = 100\,MHz$, $\lambda = 3\,m$

$f = 900\,MHz$, $\lambda = 33\,cm$

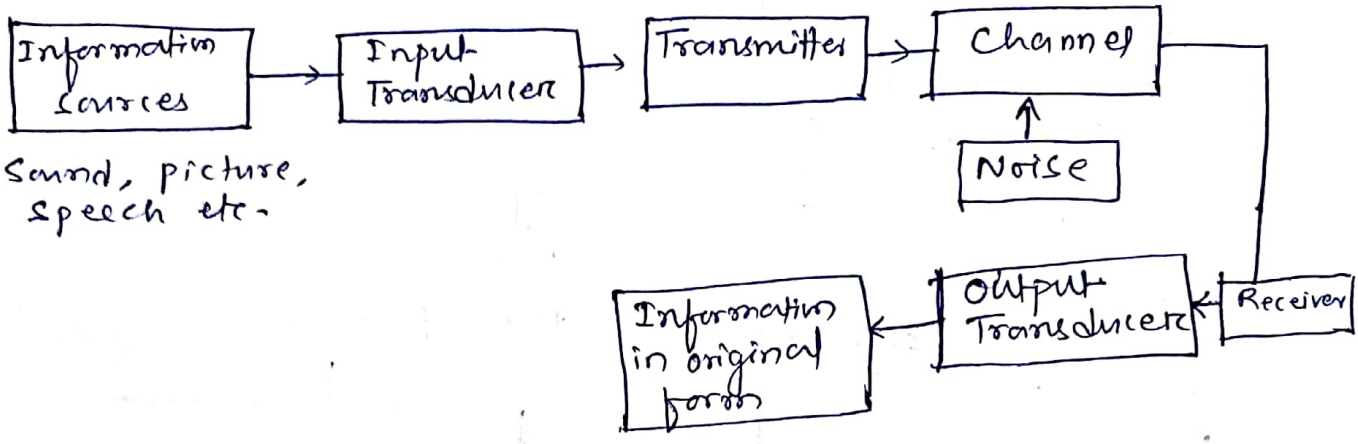
## Electromagnetic freq. Spectrum:

Freq. spectrum is the representation of a signal in freq. domain. It can be obtained by using Fourier series or fourier transform.

# Elements of Communication System:-

The purpose of a communication system is to transmit an information-bearing signal from the source to destination.

The block diagram for a comm$^n$ system is as follows:




→ Information Sources:

Information originates from any sources like, words, code, symbols, sound signals, picture, video, etc.

→ Input Transducer:-

Transducer converts one form of energy into another form. Here the i/p transducer converts information which are non-electrical in nature into time varying electrical signal.

e.g → microphone converts speech into electrical signal.

→ Transmitter:-

It prcess the electrical signal in many aspects like,

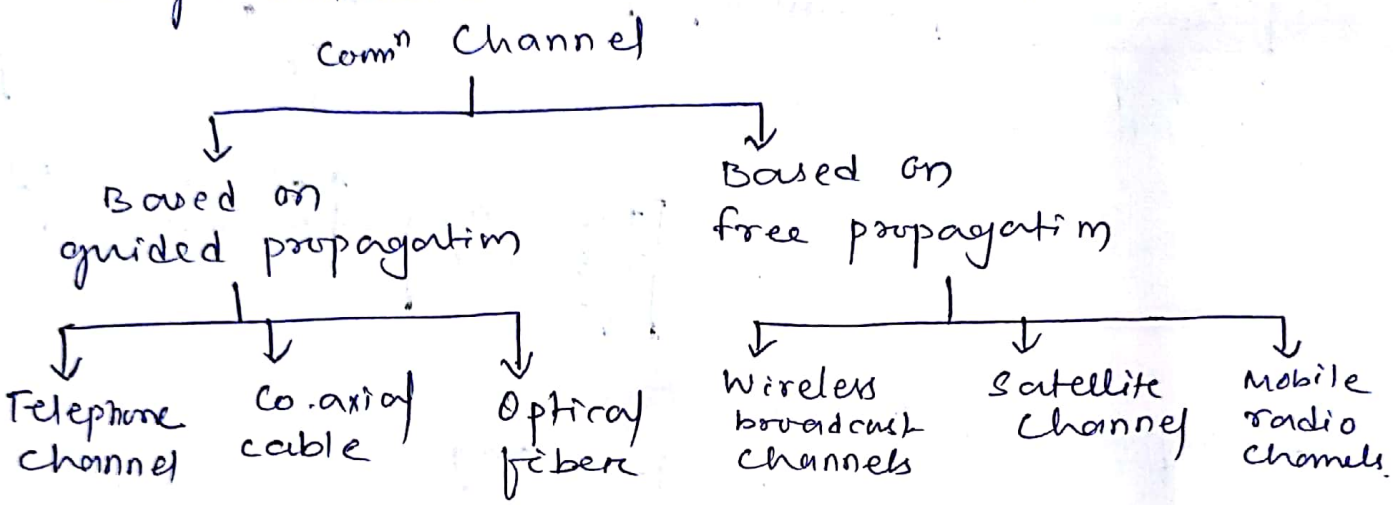
→ amplification
→ modulation
→ Analog to digital conversion (Incase of digital communication)

→ The channel & Noise:-

Channel is the medium through which the message travells from transmitter to receiver. There are two types of channel: 1) point-to-point channel
2) Broad cast channel.

→ point-to-point channels are, wire line, microwave, optical fibers link etc.

→ Broadcast channels provide a capability where several receiving stations can be reached simultaneously from a single transducer.
e.g → satellite.

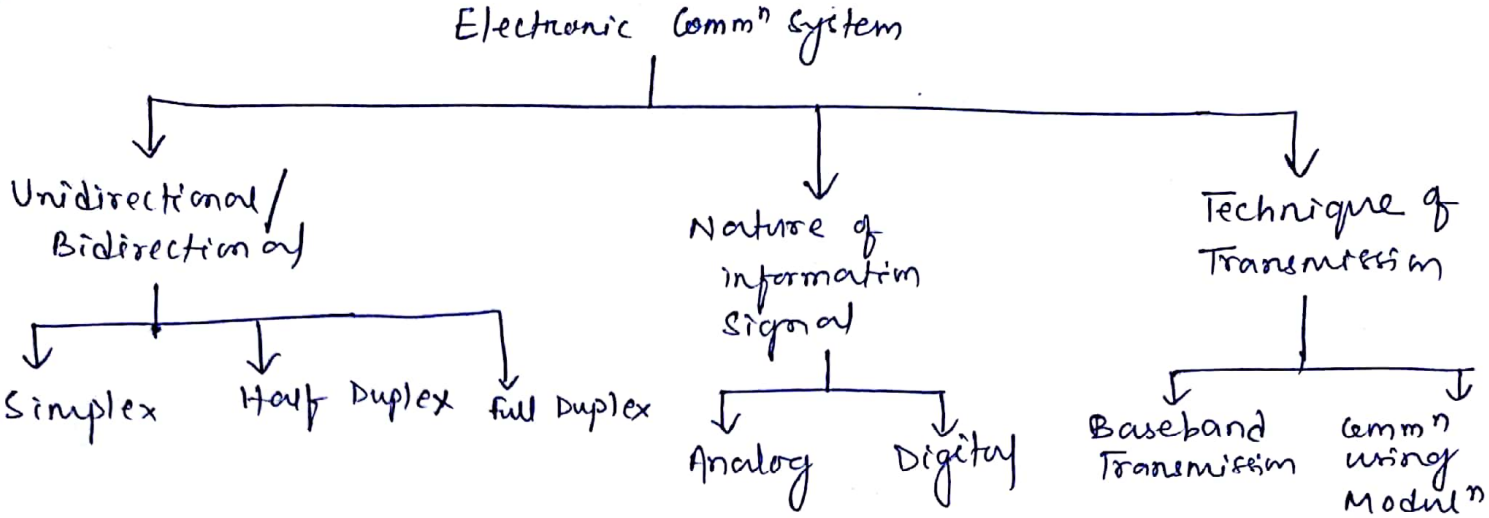



→ During the process of transmission and reception the signal gets distorted due to noise introduced in the system. Noise is always random in character.

→ Receiver:-
It reproduced the message signal in electrical form from the disterted received signal. The reproduction is done through demodulation or detection.

→ Destination:-
It is the final stage which is used to convert electrical message signal into its original form. eg → Loud Speaker

# Classification of Electronic Communication System



## Baseband Transmission :—

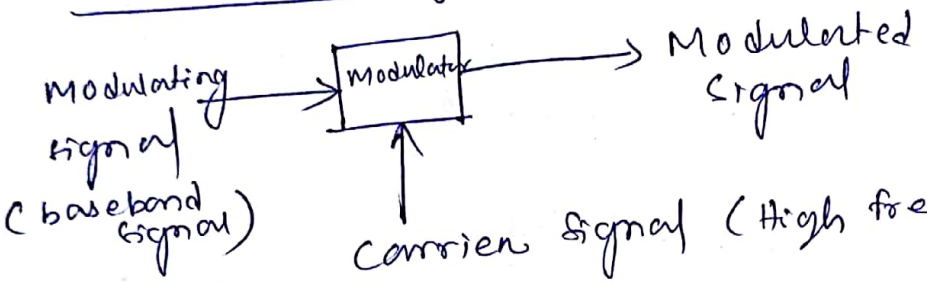
(unmodulated)

baseband signal → The baseband signals are directly transmitted thrgh the channel. e.g. → telephone networks where, the sound signal is converted into the electrical signal and are directly placed on the transmission line.

Limitation :— • it cannot be used for radio transmission where the medium is free space.

• Baseband signal cannot travel long dist.

## Communication system using Modulation :—




→ In modulation process, some parameters of the carrier wave (such as amplitude, frequency, or phase) is varied in accordance with the modulating signal.

→ On the receiver demodulation is carried out to recover the original signal.

## Need of Modulation :—

Advantages of Modulation are,

1) Reduction in the height of antenna
2) Avoids mixing of signals
3) Increase the range of communication
4) Multiplexing is possible
5) Improves quality of reception

### Reduction in the height of antenna :-

For the transmission of radio signals, the antenna height must be multiple of $(\lambda/4)$.

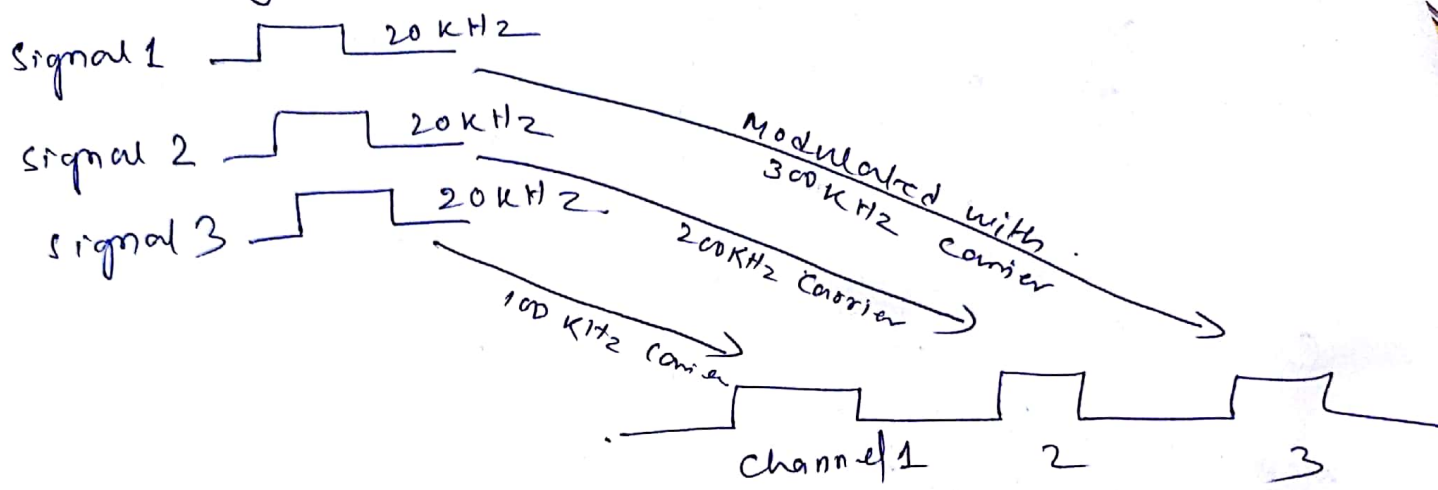
$$\lambda = \frac{c}{f}$$

e.g. For the transmission of a signal of $f = 10\,kHz$,

antenna height $= \frac{\lambda}{4} = 7500\,m$

e.g For transmission of 1 MHz signal,
Min^m antenna height = $\frac{\lambda}{4}$ = 75 meter.

→ Avoid Mixing of signal :-




→ Increase Range of communicatim :-

→ Low freq. signal cannot travel a long distance ; They get attenuated (supressed).

→ Multiplexing is possible :-

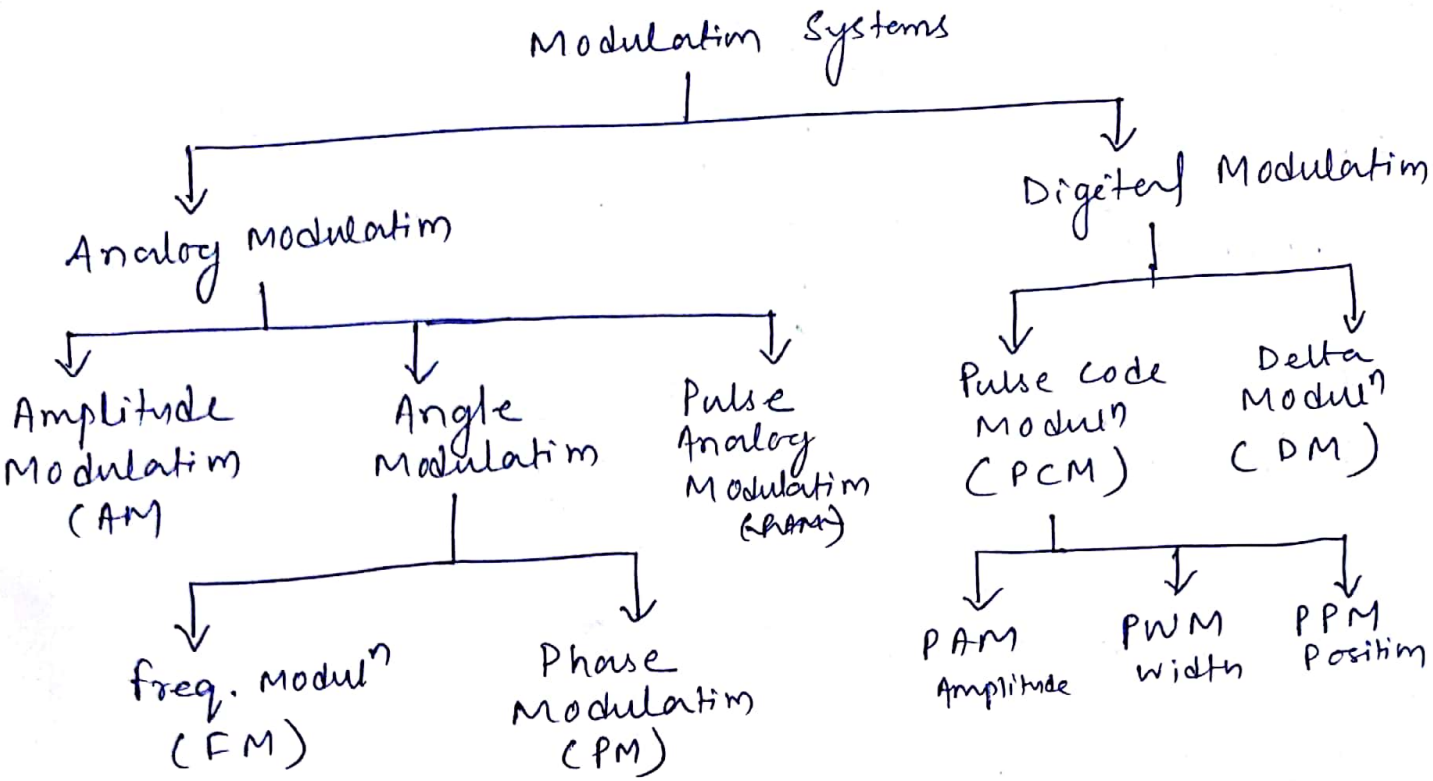
Multiplexing means two or more signals can be transmitted over the same communicatim channel simultaneously.

e.g -> many TV channels can use the same freq. range without getting mixed with each other.

→ Improves quality of Receptim :-

Effect of noise is reduced.

# Different types of Modulation




## Amplitude Modulation:

Amplitude modulation is defined as a system in which the maximum amplitude of the carrier wave is made proportional to the instantaneous value (amplitude) of the modulating or baseband signal.

$x(t)$ → modulating signal

$c(t)$ → carrier signal

$c(t) = A_c \cos \omega_c t$

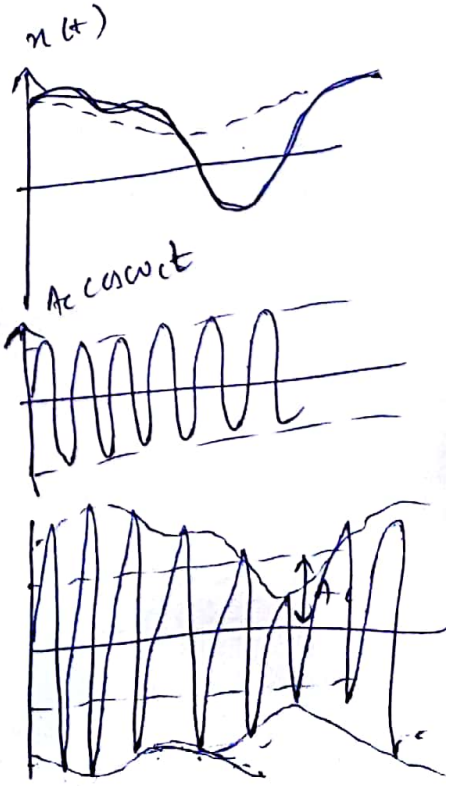
$x(t) = A_m \cos \omega_m t$

$$s(t) = x(t) \cos \omega_c t + A_c \cos \omega_c t$$

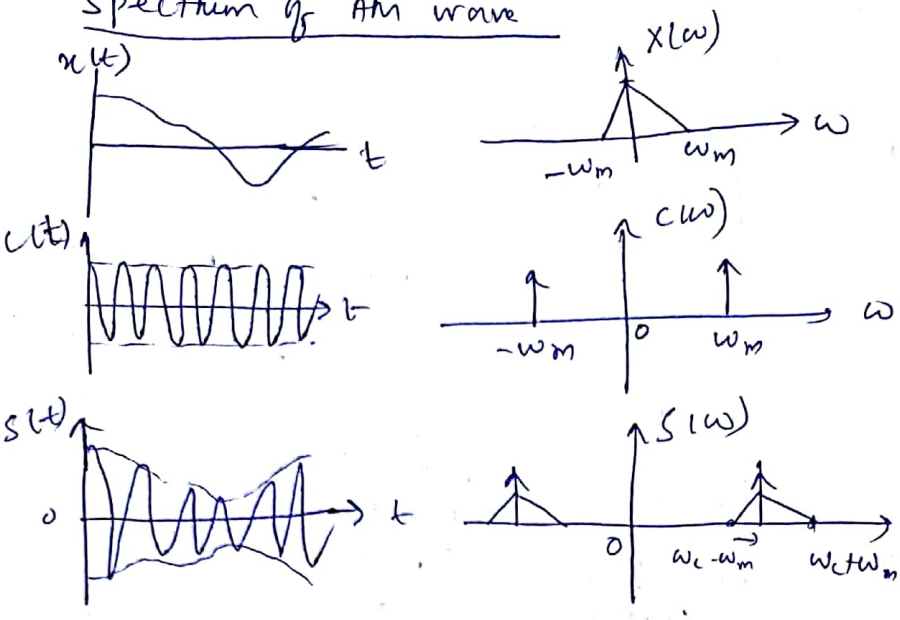
$$= \{A_c + x(t)\} \cos \omega_c t$$

$$= E(t) \cos \omega_c t$$

$E(t)$ → Envelope.



## Spectrum of AM wave




BW of AM = $\omega_c + \omega_m - \omega_c + \omega_m = 2\omega_m$

BW of AM is twice the highest freq. of modulating signal.

## Modulation index:- ($m_a$)

In AM system the modulation index is defined as the measure of extent of amplitude variation about an unmodulated maxm carrier.

$$m_a = \frac{|x(t)|_{max}}{\text{Max}^m \text{ carrier amplitude}}$$

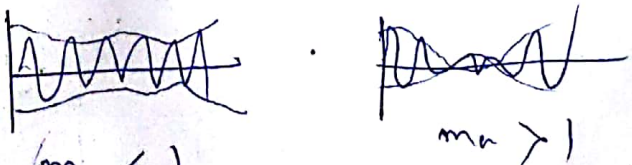
$$= \frac{\text{max}^m \text{ amplitude of modulating signal}}{\text{max}^m \text{ " " carrier "}} = \frac{A_m}{A_c}$$

% modulation $m_a \times 100\%$.

The modulating signal will be preserved in the envelope of AM signal only if % age modulⁿ is less than or equal to 100%.

i.e. if $m_a \leq 1$ then modulating signal can be recovered

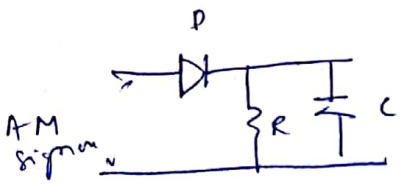
if $m_a > 1$, i.e % modulⁿ is more than 100%, the baseband signal is not presented in the envelope. It will be distorted. and is called over modulⁿ.

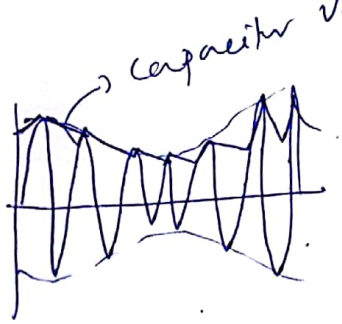


$m_a < 1$ $\quad$ $m_a > 1$

## Single tone AM

### Demodulation




**Q** A carrier signal $v_c(t) = 5 \sin(2\pi \times 10^6)t$ is amplitude modulated by a modulating sinusoidal signal $v_m(t) = \sin(4\pi \times 10^3)t$. Write the expression for the resulting AM signal.

Carrier signal → Amplitude $A_c = 5$, $f_c = 10^6$

modulating " " $A_m = 1$, $f_m = 2 \times 10^{-3}$

$$V_{AM}(t) = [A_c + v_m(t)] \sin(2\pi \times 10^6)$$

$$= [5 + \sin(2\pi \times 10^3)t] \sin(2\pi 10^6 t)$$

**Q** A carrier signal with an RMS volt. of 2V & freq. of 30 MHz is amplitude modulated by a modulating sinusoidal signal with a freq. of 500 Hz & maxm amplitude of 1.4V. Write the expression for the resulting AM signal.

$A_c|_{rms} = 2V$, $A_c = 2\sqrt{2} = 2.8V$.

$A_m = 1.4V$

$f_m = 500Hz$

$f_c = 30 MHz$

$$V_{AM}(t) = 2.8 + 1.4 \sin(2\pi \times 500t) \sin(2\pi \times 30 \times 10^6 t)$$

Bandwidth of AM signal = $B_{AM} = 2 f_m$ $f_c + f_m - f_c + f_m$