Sri SAI RAM ENGINEERING COLLEGE
INSTITUTE OF TECHNOLOGY
West Tambaram, Chennai - 44

Sairam INSTITUTIONS

SAIRAM DIGITAL RESOURCES

YEAR II

SEM III

EC8394

ANALOG AND DIGITAL COMMUNICATION

UNIT NO 1

ANALOG COMMUNICATION

- COMPARISON OF AM,FM&PM
- ADAVANTAGES OF AM&FM
- DISADAVANTAGES OF AM&FM

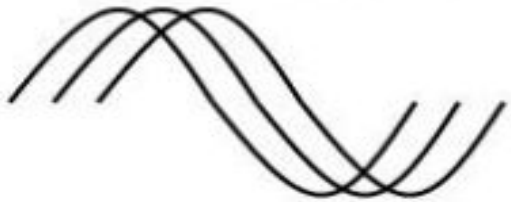
ELECTRONICS & COMMUNICATION ENGINEERING

4 QUALITY EDUCATION

Amplitude, Frequency and Phase Modulation

Amplitude Modulation

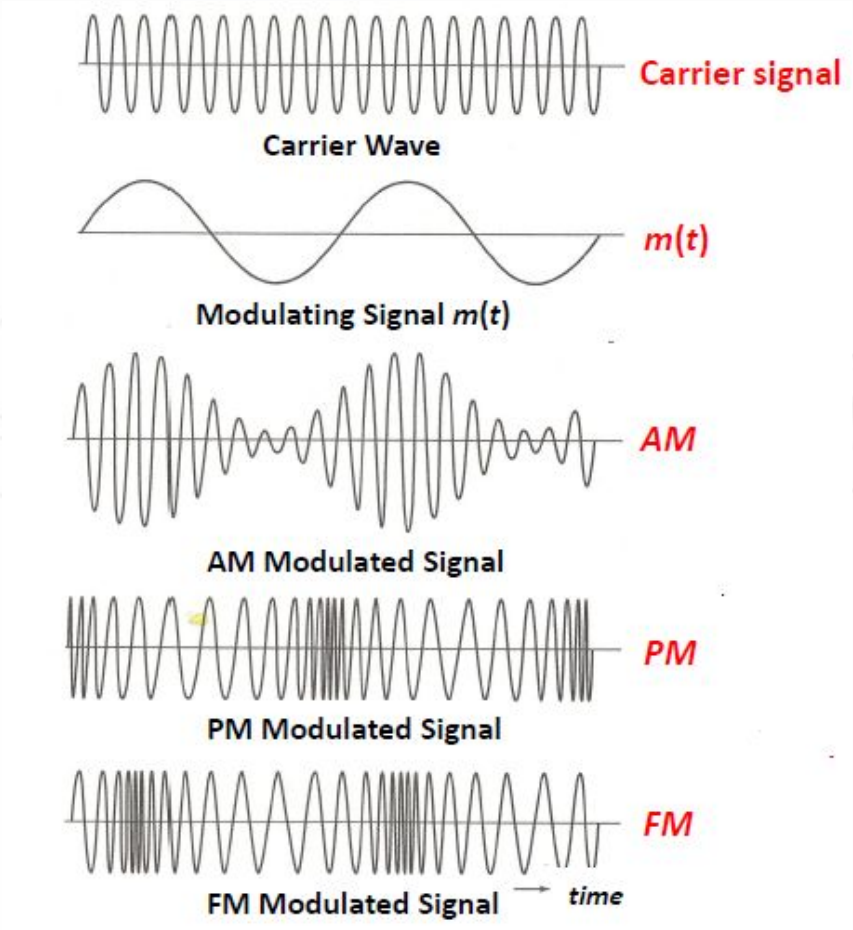
Phase Modulation



Frequency Modulation

With few exceptions, Phase Modulation (PM) is used primarily in digital communication

Illustrating AM, PM and FM Signals



Comparing Frequency Modulation to Phase Modulation

#	Frequency Modulation (FM)	Phase Modulation (PM)
1	Frequency deviation is proportional to modulating signal $m(t)$	Phase deviation is proportional to modulating signal $m(t)$
2	Noise immunity is superior to PM (and of course AM)	Noise immunity better than AM but not FM
3	Signal-to-noise ratio (SNR) is better than in PM	Signal-to-noise ratio (SNR) is not as good as in FM
4	FM is widely used for commercial broadcast radio (88 MHz to 108 MHz)	PM is primarily for some mobile radio services
5	Modulation index is proportional to modulating signal $m(t)$ as well as modulating frequency f_m	Modulation index is proportional to modulating signal $m(t)$

Phase Modulation (PM)

$$\theta(t) = \omega_C t + \theta_0 + k_p m(t) \qquad \text{Generally we let } \theta_0 = 0.$$

Let $\theta_0 = 0$

$$\varphi_{PM}(t) = A\cos(\omega_C t + k_p m(t))$$

The instantaneous angular frequency (in radians/second) is

$$\omega_i(t) = \frac{d\theta(t)}{dt} = \omega_C + k_p \frac{m(t)}{dt} = \omega_C + k_p \dot{m}(t)$$

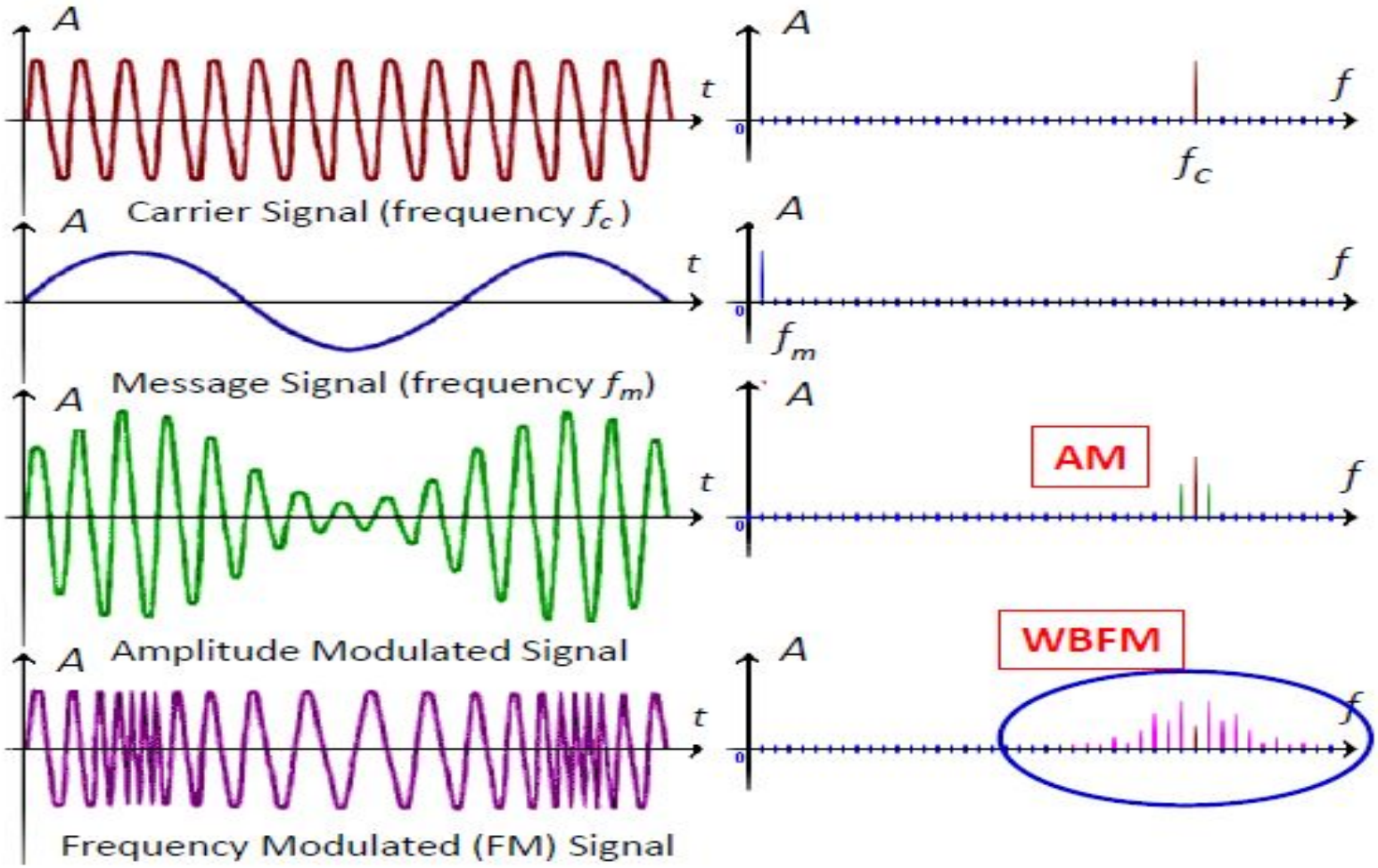
In phase modulation (PM) the instantaneous angular frequency ω_i varies linearly with the derivative of the message signal m(t) (denoted here by $\dot{m}(t)$).

k_p is phase-deviation (sensitivity) constant. Units: radians/volt
[Actually in radians/unit of the parameter $m(t)$.]

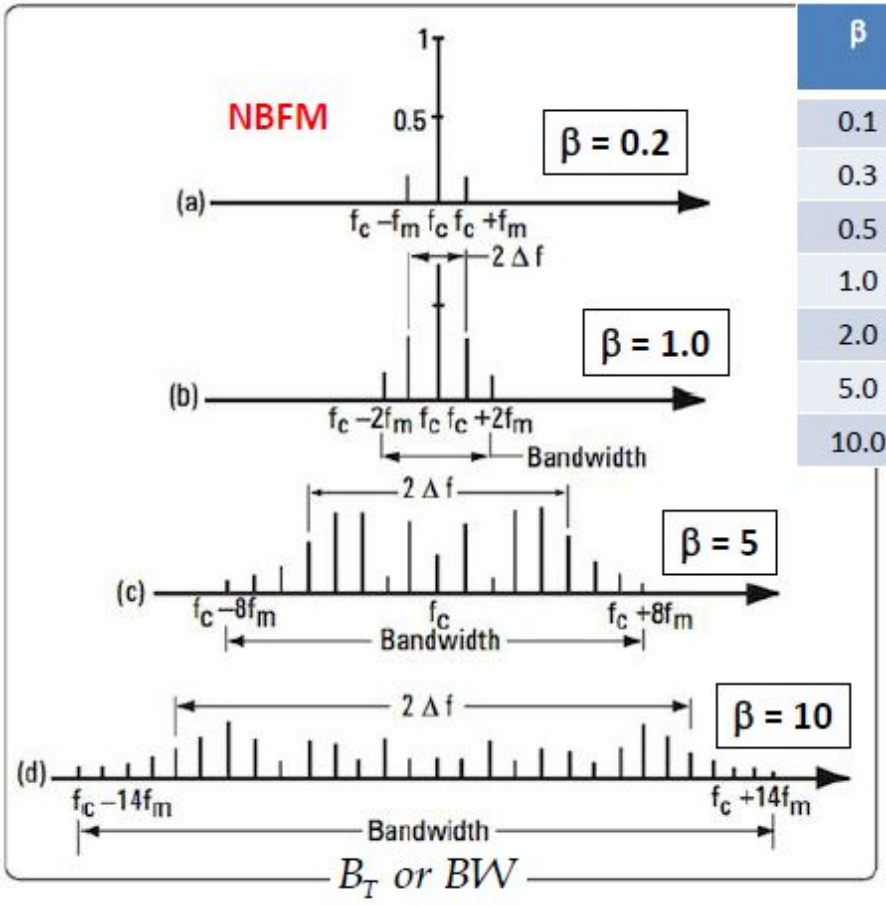
Comparison of FM (or PM) to AM

#	Frequency Modulation (FM)	Amplitude Modulation (AM)
1	FM receivers have better noise immunity	AM receivers are very susceptible to noise
2	Noise immunity can be improved by increasing the frequency deviation	No such option exists in AM
3	Bandwidth requirement is greater and depends upon modulation index	Bandwidth is less than FM or PM and doesn't depend upon a modulation index
4	FM (or PM) transmitters and receivers are more complex than for AM	AM transmitters and receivers are less complex than for FM (or PM)
5	All transmitted power is useful so FM is very efficient	Power is wasted in transmitting the carrier and double sidebands in DSB (but DSB-SC addresses this)

FM (or PM) Requires Much More Bandwidth Than AM



FM Spectra as Function of Modulation Index



β	Number of Sidebands¶	Bandwidth
0.1	2	$2f_m$
0.3	4	$4f_m$
0.5	4	$4f_m$
1.0	6	$6f_m$
2.0	8	$8f_m$
5.0	16	$16f_m$
10.0	28	$28f_m$

Single tone modulation

$$\beta = \frac{\Delta f}{f_m}$$

Advantages of FM

1. ***Resilient to noise:*** The main advantage of frequency modulation is a reduction in noise. As most noise is amplitude based, this can be removed by running the received signal through a limiter so that only frequency variations remain.

2. ***Resilient to signal strength variations:*** In the same way that amplitude noise can be removed, so too can signal variations due to channel degradation because it does not suffer from amplitude variations as the signal level varies. This makes FM ideal for use in mobile applications where signal levels constantly vary.

3. ***Does not require linear amplifiers in the transmitter:*** As only frequency changes contain the information carried, amplifiers in the transmitter need not be linear.

4. ***Enables greater efficiency :*** The use of non-linear amplifiers (*e.g.,* class C and class D/E amplifiers) means that transmitter efficiency levels can be higher. This results from linear amplifiers being inherently inefficient.

Disadvantages of FM

1.Requires more complicated demodulator:

Demodulator is more complicated, and hence more expensive than the very simple diode detectors used in AM.

2.Sidebands extend to infinity either side:

The sidebands for an FM transmission theoretically extend out to infinity. To limit the bandwidth of the transmission, filters are used, and these introduce some distortion of the signal.