# Communication Systems

Lecture # 08

# Amplitude Modulation

- Modulation is a process that causes a shift in the range of frequencies in a signal
- Two types of communication
  - Baseband Communication
    - Doesn’t use modulation
  - Band pass Communication
    - That uses modulation

# Baseband Communication

- The term baseband is used to designate the band of frequencies of the signal delivered by the source or the input transducer (Telephony, 0-3.5 KHz)
- The signals are transmitted without modulation
- The baseband signals have sizable power at low frequencies, they cannot be transmitted over a radio link, but suitable for transmission over a pair of wires, coaxial cables, optical fibers.
- Local telephone communication, short haul PCM between two exchanges, and long-distance PCM over optical fibers

# Carrier Communication

- Uses modulation to shift the frequency spectrum
- One of the basic parameters (amplitude, frequency, or phase) of a sinusoidal carrier of high frequency $\mathbf{w_c}$ is varied in proportion to baseband signal **m(t)**
- Amplitude Modulation (AM), Frequency Modulation (FM) or Phase Modulation (PM)
- FM and PM belong to the class of modulation called Angle Modulation
- Modulation is used to transmit analog as well as digital baseband signals

# Amplitude Modulation

- There are several different ways of amplitude modulating the carrier signal by m(t); each results in different spectral characteristics for the transmitted signals.
- Double Sideband- Suppressed Carrier AM
- Conventional Double Sideband AM
- Single Sideband AM
- Vestigial Sideband AM

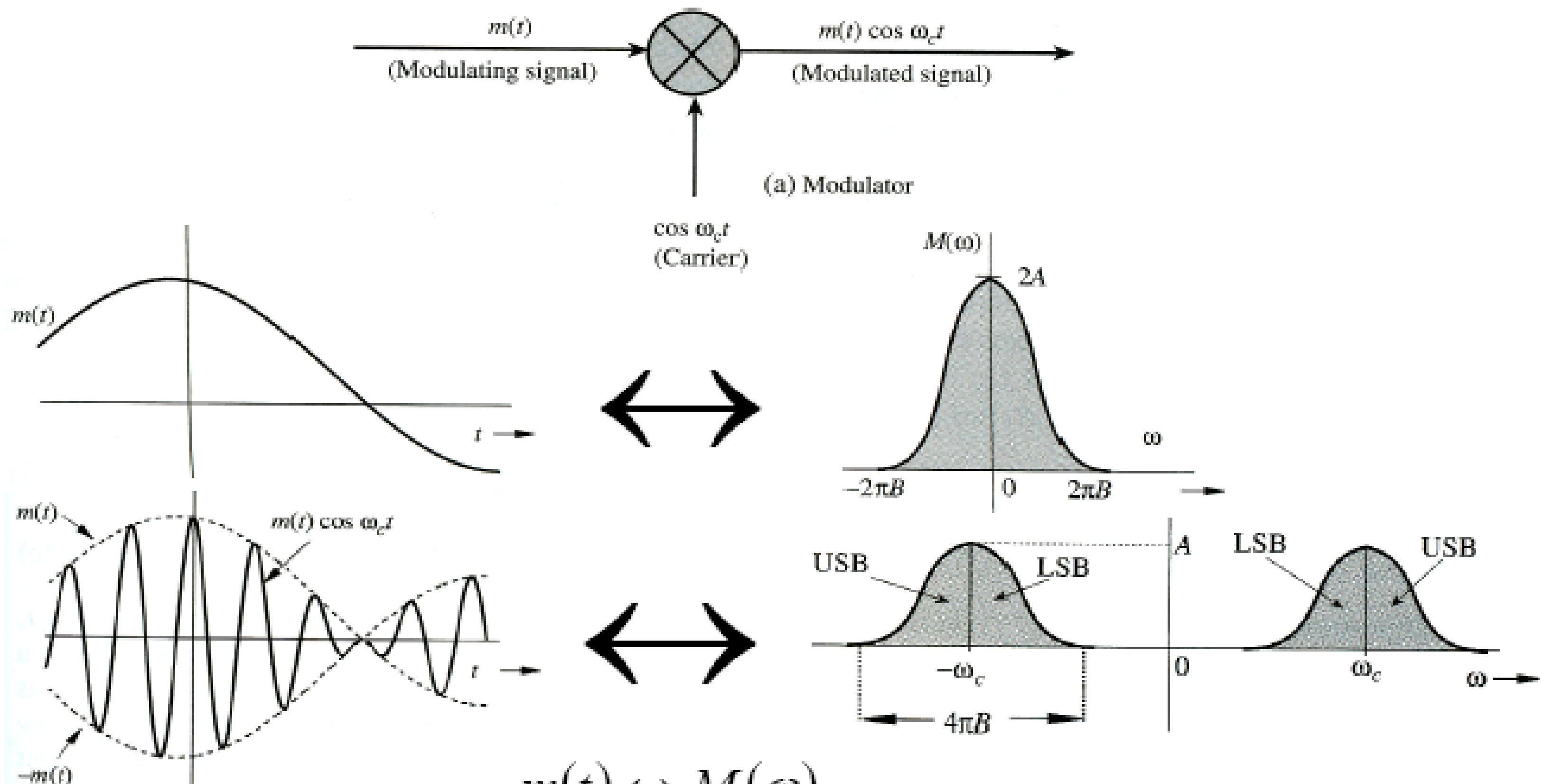
# Amplitude Modulation

- Double Sideband-Suppressed Carrier, DS-SC
- Carrier Signal: $A \cos(\omega_c t + \theta_c)$
- Amplitude 'A' is varied in proportion to the baseband signal m(t), the modulating signal, frequency and phase are constant
- If the carrier amplitude is made directly proportional to the modulating signal m(t), the modulated signal is

$$m(t)\cos(\omega_c t)$$

- This type of modulation simply shifts the spectrum of m(t) to the carrier frequency

# Amplitude Modulation




$$m(t) \leftrightarrow M(\omega)$$

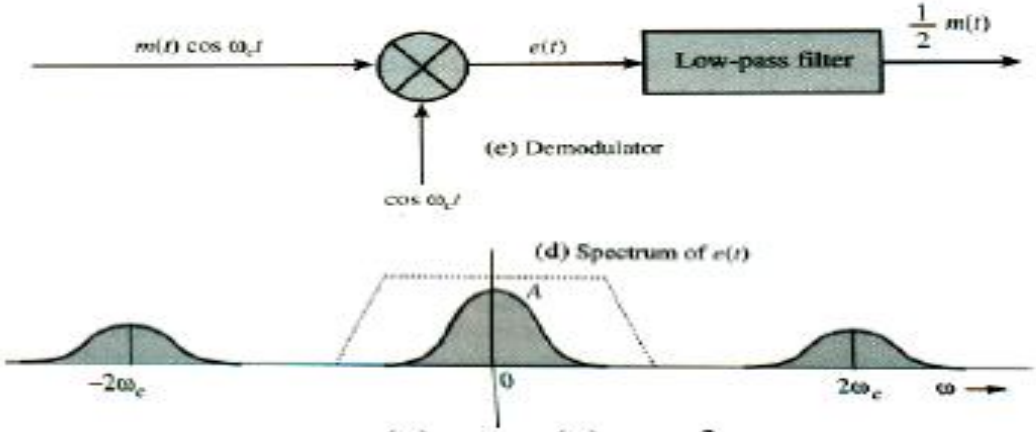
$$m(t)\cos\omega_c t \leftrightarrow \frac{1}{2}[M(\omega+\omega_c)+M(\omega-\omega_c)]$$

- The relationship of B to $w_c$ is of interest.

# Demodulation

– Demodulation

Retranslating the spectrum to its original position is referred to as demodulation




$$e(t) = m(t)\cos^2 \omega_c t$$

$$e(t) = \frac{1}{2}[m(t) + m(t)\cos 2\omega_c t]$$

$$E(\omega) = \frac{1}{2}M(\omega) + \frac{1}{4}[M(\omega + 2\omega_c) + M(\omega - 2\omega_c)]$$

# Demodulation

– This type of demodulation is called **synchronous** detection, or **coherent** detection
– In demodulator, we use the carrier of same frequency and phase as used in modulation
– Thus the need to generate a local carrier at the receiver in frequency and phase coherence (synchronism)
– Distortion occur if the frequency and phase of the carrier is not the same at receiver

# Questions?