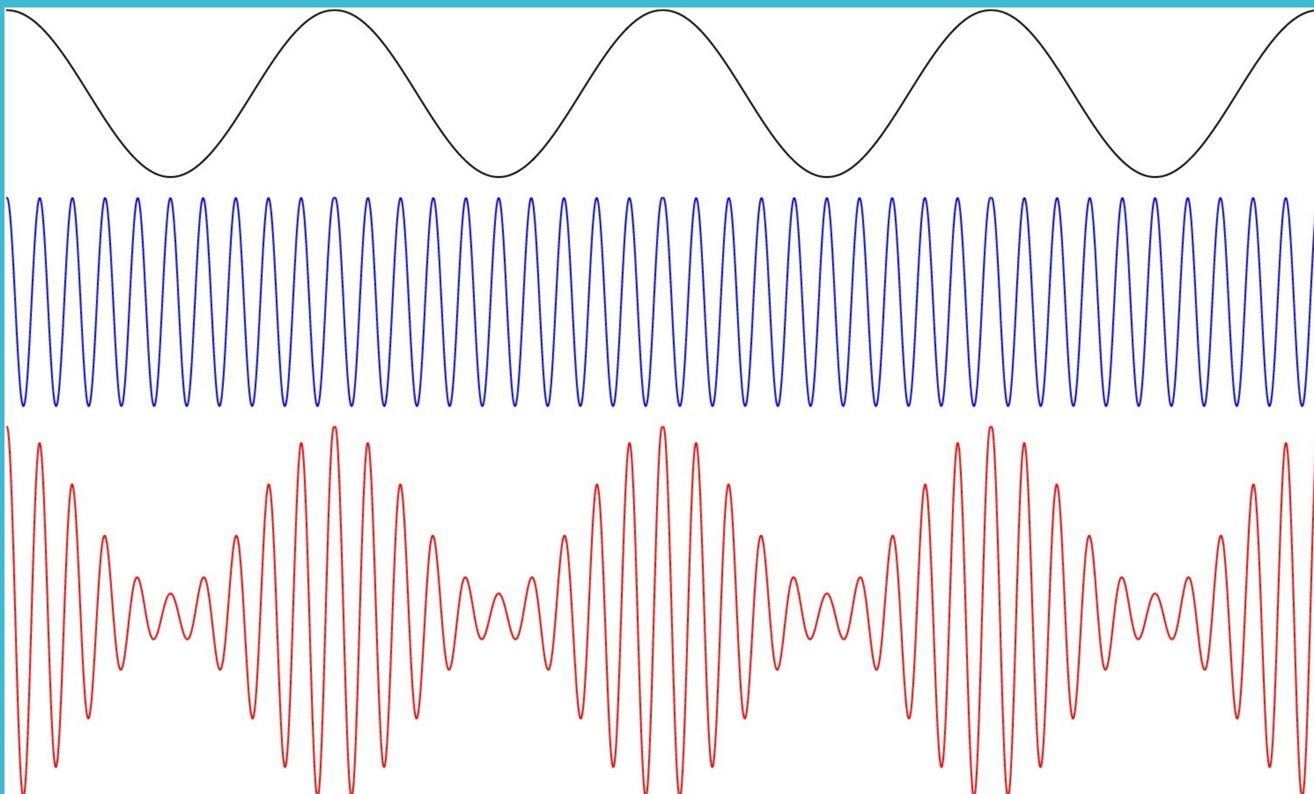

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Department of Information and Communication Technology

Subject name: Analog and Digital Communication

Subject code: 01CT0404

Prof. Sunera G. Kargathara

Marwadi University

Department of Information and Communication Technology

Course Content

Linear Modulation: Amplitude modulation

Concept of amplitude modulation, Double Sideband suppressed carrier modulation, Single side band suppressed carrier modulation, Generation of AM- Chopper circuit, Balanced modulator, Modulation by multitone modulating signal. Independent Side band, Theme example- VSB transmission of Analog and Digital Television.

Angle modulation

Concept of instantaneous frequency and phase modulation, sinusoidal FM and its time domain representation, spectral components of angle modulated signals, power in sinusoidal FM and modulation index, Carson's rule, Multitone wideband FM, Generation of Wideband FM from Narrow band FM , Generation of WBFM by Armstrong method.

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Course Content

Noise in communication systems

Classification of noise, Signal to noise ratio (SNR), Noise factor and noise figure, Equivalent input noise generators, Noise temperature, Narrow band noise, PSD of in-phase and quadrature noise, Noise performance in AM, FM, Digital baseband and carrier communication systems, Concept of optimum threshold detection, matched filter, correlation receiver, optimum binary receiver, bit error rate (BER).

Base Band Modulation

Base band system, sampling theorem, Sampling and signal reconstruction, Aliasing, Types of sampling, Quantization, PCM, Companding, DPCM, ADPCM, Delta modulation, Adaptive delta modulation. Theme Example- Digitization of video and MPEG.

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Course Content

Digital Modulation Techniques

Modulation techniques for ASK, QASK, FSK, M-ary FSK, BPSK, DPSK, QPSK, M-ary PSK, QAM. Comparison of Noise performance of various PSK and FSK systems. Theme Example- Orthogonal Frequency Division Multiplexing (OFDM).

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Course Outcomes

1. To understand basics of analog and digital communication techniques.
2. To learn working of AM-FM Transmitters and receivers.
3. To facilitate the understanding of the baseband and carrier modulation.
4. To understand the effect and performance of communication systems in presence of noise.
5. Analyze Communication System based on different Modulation & Demodulation Techniques and analyze performance.

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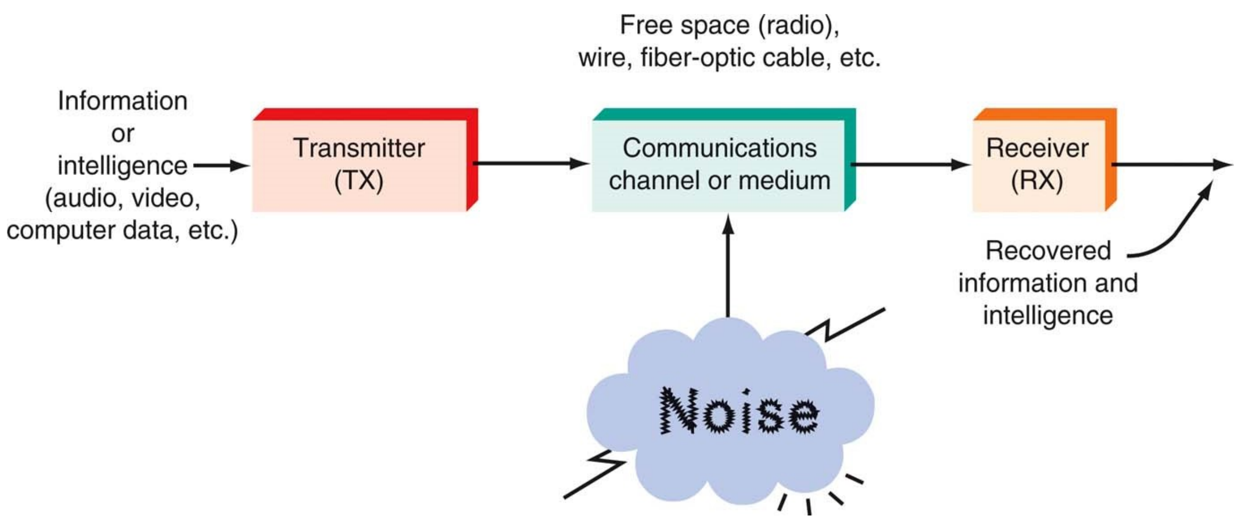
Classification of Electronic Communication System:

- Based on direction of communication
  - Simplex
  - Half duplex
  - Full duplex
- Nature of information signal
  - Analog
  - Digital
- Transmission technique
  - Baseband Transmission
  - Using modulation

Basic Communication System :



Modulation

Modulation is defined as the process of **modifying a carrier signal** (radio wave) systematically by the modulating signal (audio)”

This process makes the signal suitable for the transmission and compatible with the channel.

The resultant signal is called the modulated signal

Need of Modulation ??

Need of Modulation :

- ❑Avoids mixing of signals
- ❑Reduce height of antenna
- ❑Increase in range in communication
- ❑Multiplexing is possible
- ❑Improves quality of reception

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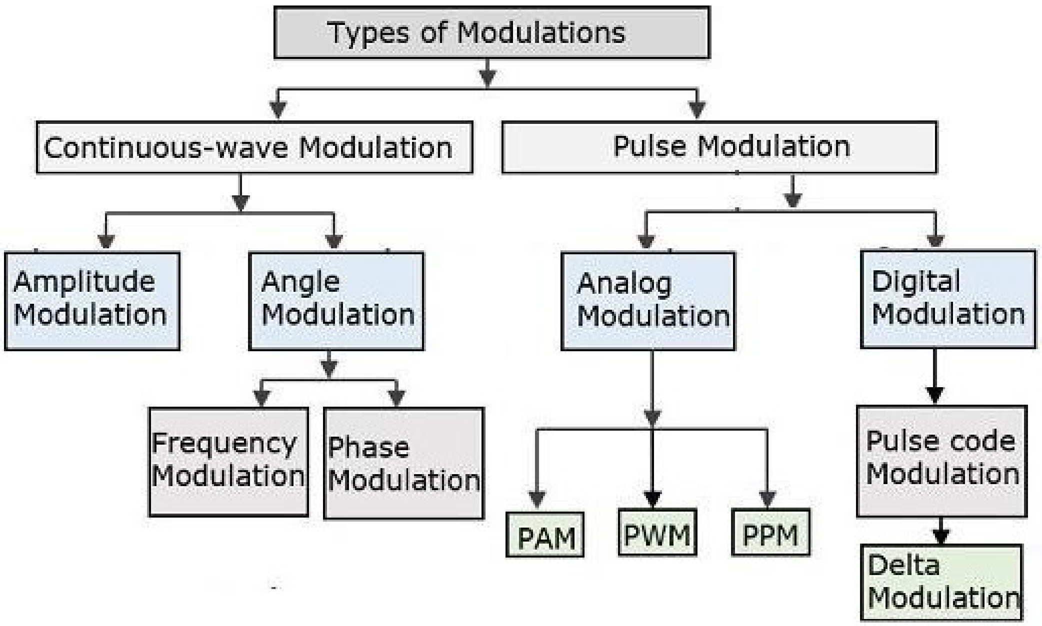
Types of Modulation

There are many types of modulations. Depending upon the modulation techniques used, they are classified as shown in the following figure.



The types of modulations are broadly classified into continuous-wave modulation and pulse modulation.

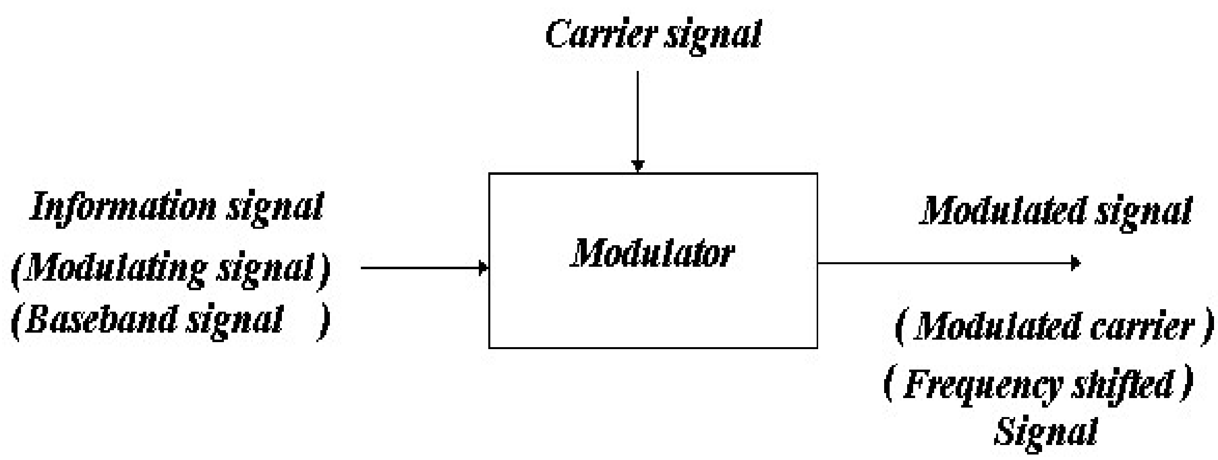
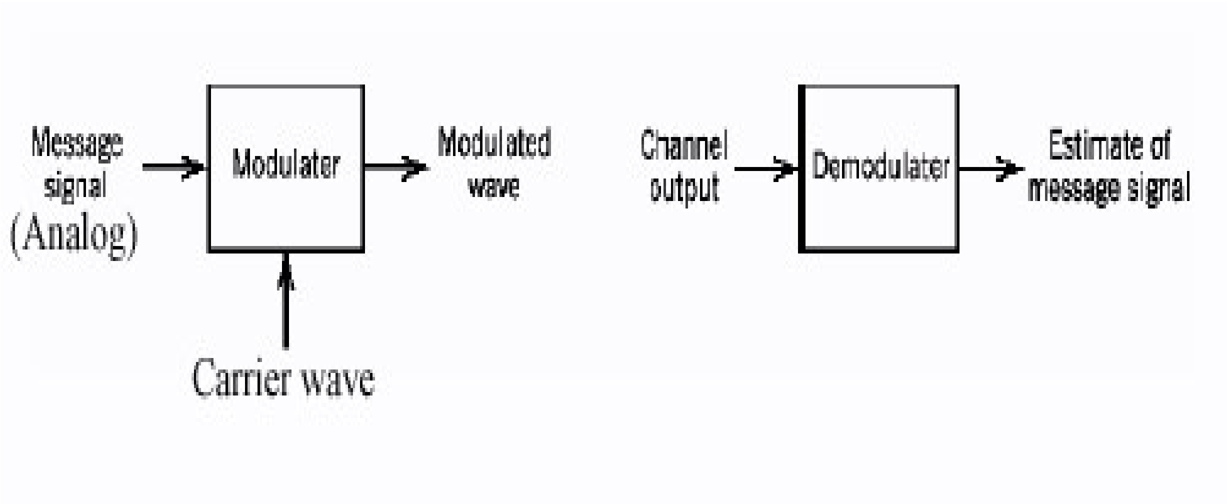
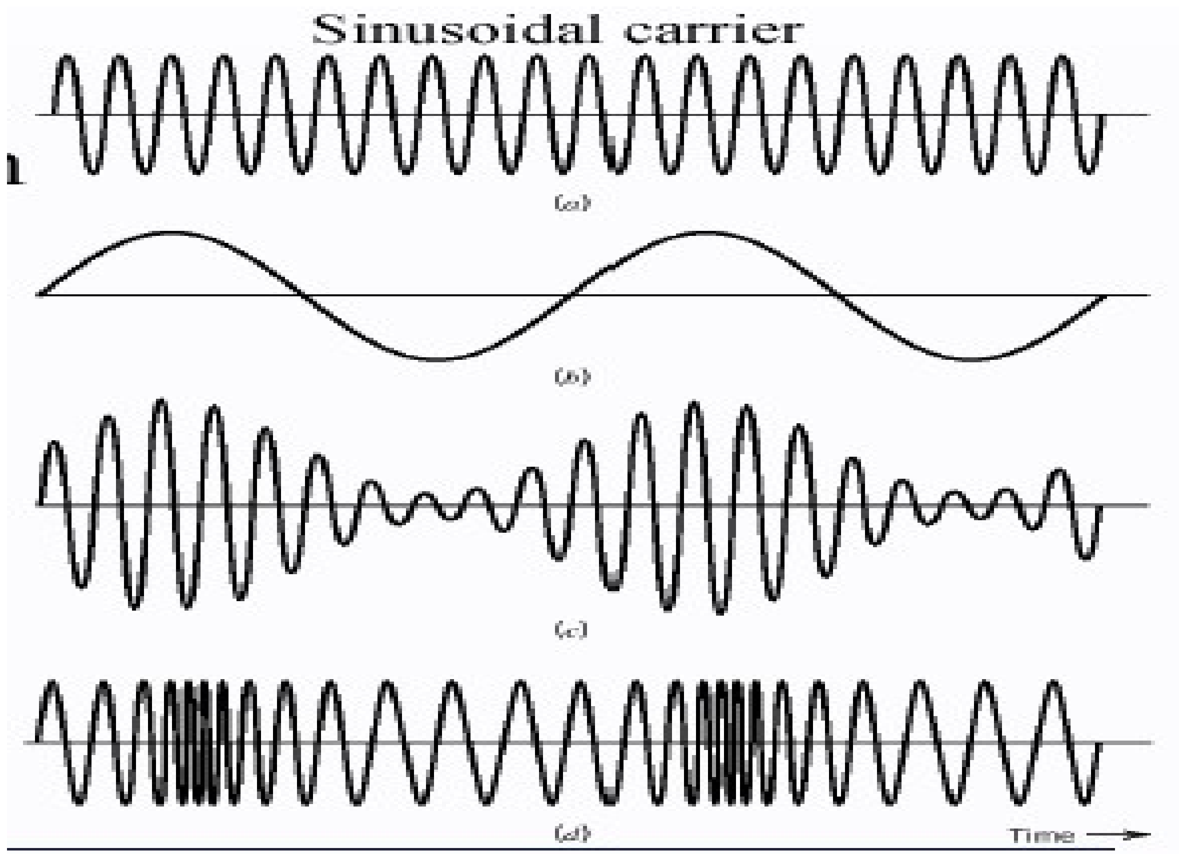


Fig. Process of Modulation

TRANSMISSION+ RECEPTION




Sinusoidal carrier
(a)
(b)
(c)
(d)
Time

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Signals in the Modulation Process

Following are the three types of signals in the modulation process.

Message or Modulating Signal

The signal which contains a message to be transmitted, is called as a **message signal**. It is a baseband signal, which has to undergo the process of modulation, to get transmitted. Hence, it is also called as the **modulating signal**.

Carrier Signal

The high frequency signal, which has a certain amplitude, frequency and phase but contains no information is called as a **carrier signal**. It is an empty signal and is used to carry the signal to the receiver after modulation.

Modulated Signal

The resultant signal after the process of modulation is called as a **modulated signal**. This signal is a combination of modulating signal and carrier signal.

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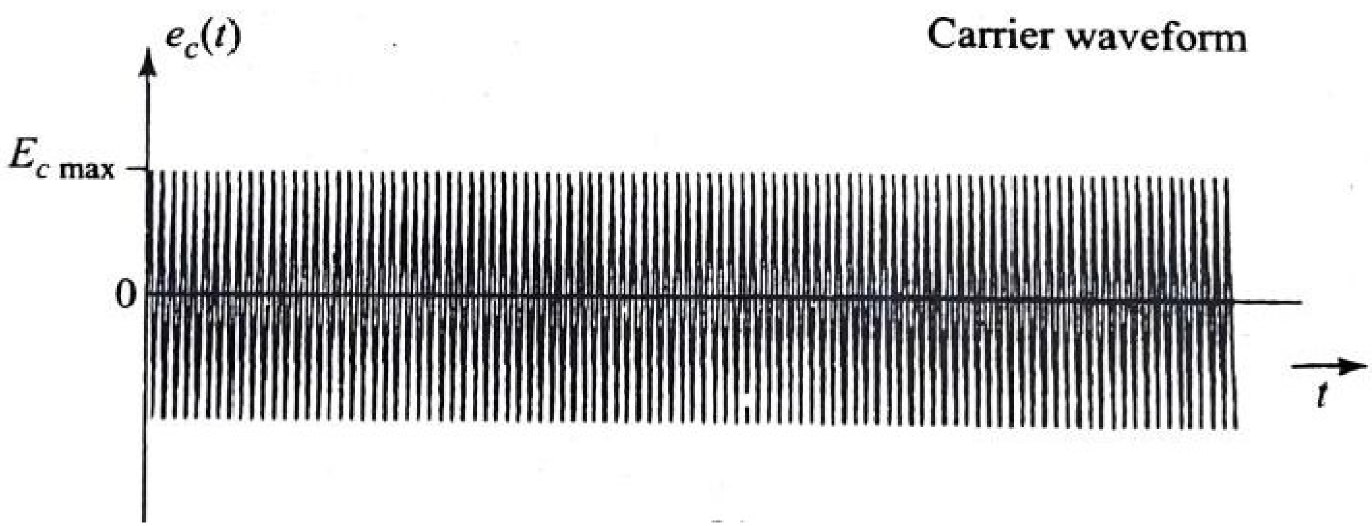
$$e_c(t) = E_{c\,\max} \sin(2\pi f_c t + \phi_c)$$

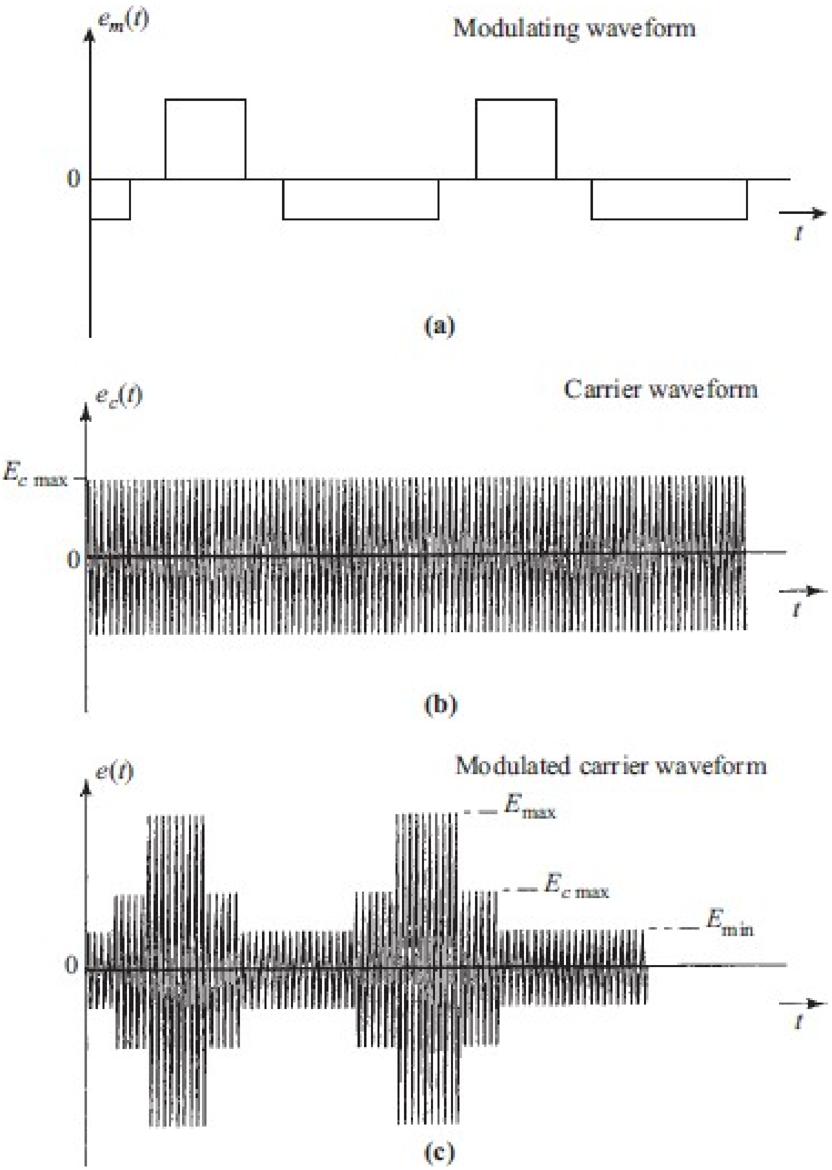


In amplitude modulation a voltage proportional to the modulating signal is added to the carrier amplitude. Let the added component of voltage be represented in functional notation as $e_m(t)$; then the modulated carrier wave is given by

$$e(t) = [E_{c\,\max} + e_m(t)]\cos(2\pi f_c t + \phi_c) \tag{8.2.1}$$

The term $[E_{c\ \max} + e_m(t)]$ describes the *envelope* of the modulated wave. Figure 8.2.1 shows (a) an arbitrary modulating signal, (b) a carrier wave, and (c) the resulting AM wave, where the envelope is seen to follow the modulating signal waveform. This also illustrates graphically why the term *carrier* is used.

Credit: Electronic Communication by Roddy and Coolen



Credit: Electronic Communication by Roddy and Coolen

Referring to Fig. 8.2.1(c), the *modulation index* is defined as

$$m = \frac{E_{\max} - E_{\min}}{E_{\max} + E_{\min}} \tag{8.3.1}$$

In the case of a periodic modulating signal, such as shown in Fig. 8.2.1, it is easy to identify the maximum and minimum voltages of the modulated wave. With a nonperiodic signal, such as a speech waveform, these quantities will vary, and hence the modulation index will also vary. What is important is that the modulation index must not be allowed to exceed unity. If the modulation index exceeds unity the negative peak of the modulating waveform is clipped, as shown in Fig. 8.3.1. This is bad enough in itself, but, in addition, such clipping is a potential source of interference, as will be shown shortly.

It will be noticed that overmodulation ($m > 1$) occurs when the magnitude of the peak negative voltage of the modulating wave exceeds the peak carrier voltage. Under these conditions in practice, $E_{\min}$ is clamped at zero, as shown in Fig. 8.3.1(b). The mathematical expression for the modulated wave, Eq. (8.2.1), is not valid under these conditions. The envelope $[E_{c\ \max} + e_m(t)]$ goes negative, which mathematically appears as a phase-reversal rather than a clamped level.

Viewing the modulated waveform directly on an oscilloscope is difficult when the modulating waveform is other than periodic because of the problem of synchronizing the sweep to obtain a stationary pattern.

Credit: Electronic Communication by Roddy and Coolen

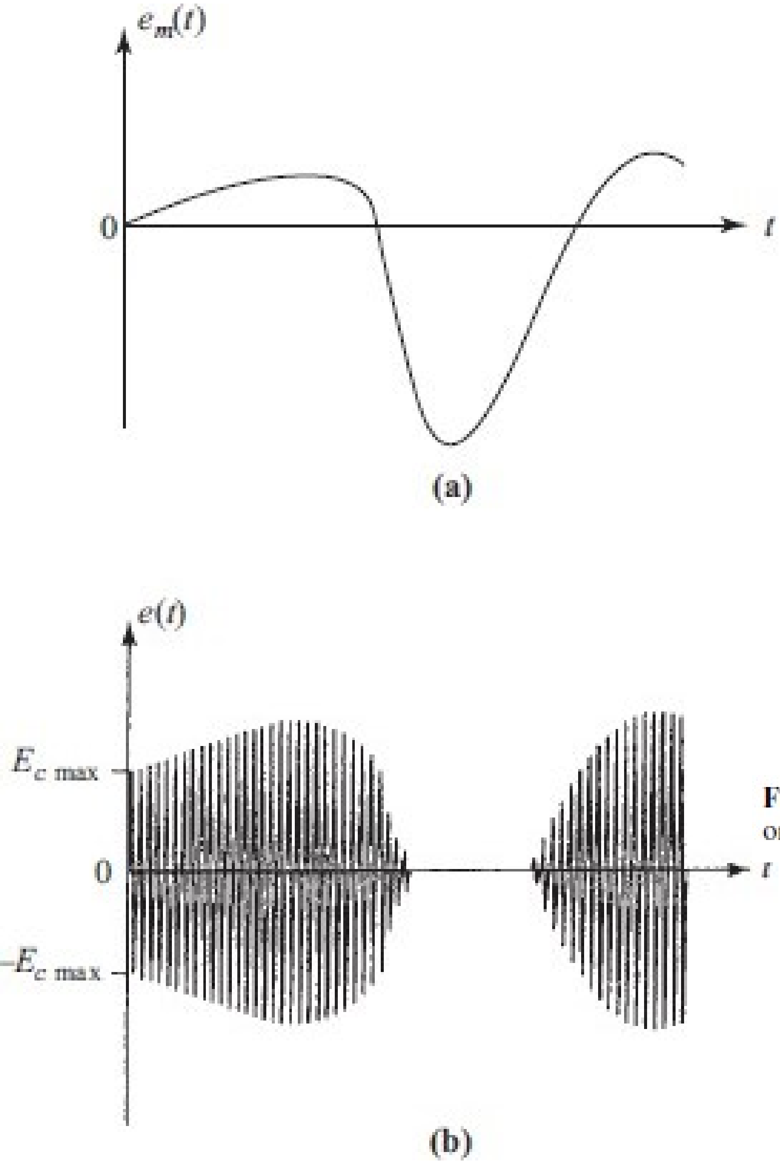


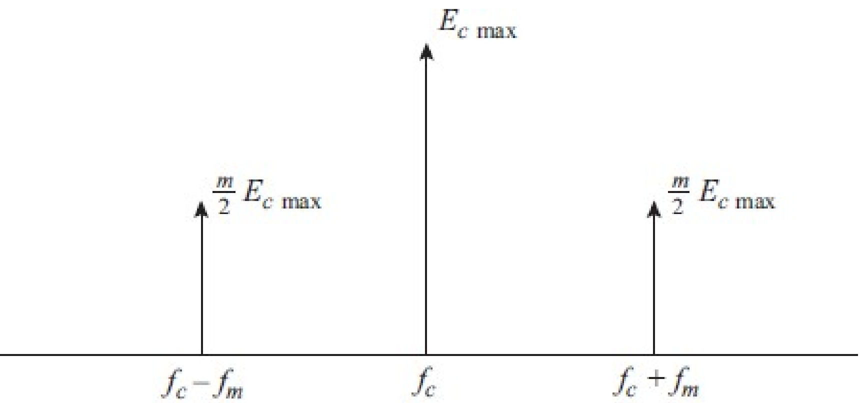
Figure 8.3.1 AM wave for which $m > 1$. (a) Modulating waveform and (b) the modulated waveform, showing clipping on the negative modulation peaks.

Credit: Electronic Communication by Roddy and Coolen

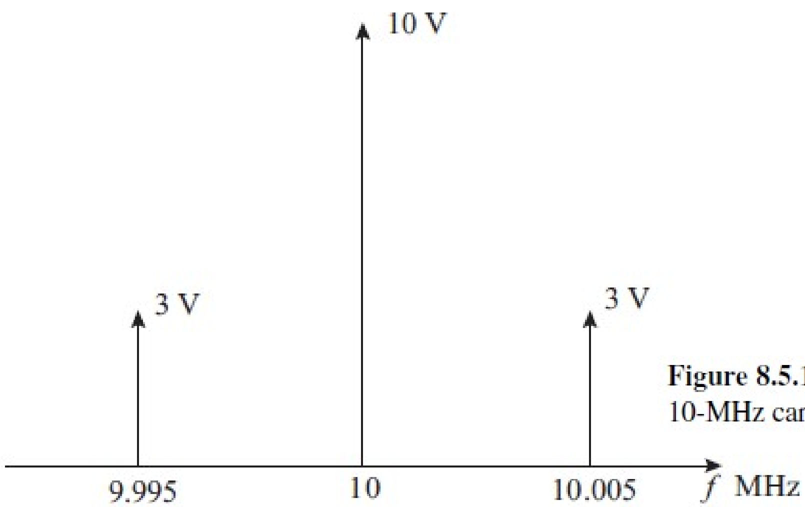
A carrier wave of frequency 10 MHz and peak value 10 V is amplitude modulated by a 5-kHz sine wave of amplitude 6 V. Determine the modulation index and draw the amplitude spectrum.

SOLUTION $m = \frac{6}{10} = 0.6$

The side frequencies are $10 \pm 0.005 = 10.005$ and 9.995 MHz. The amplitude of each side frequency is $0.6 \times 10/2 = 3$ V. The spectrum is shown in Fig. 8.5.1(b).



(a)



(b)

Figure 8.5.1 (a) Amplitude spectrum for a sinusoidally amplitude modulated wave. (b) The amplitude spectrum for a 10-MHz carrier of amplitude 10 V, sinusoidally modulated by a 5-kHz sine wave of amplitude 6 V (Example 8.5.1).