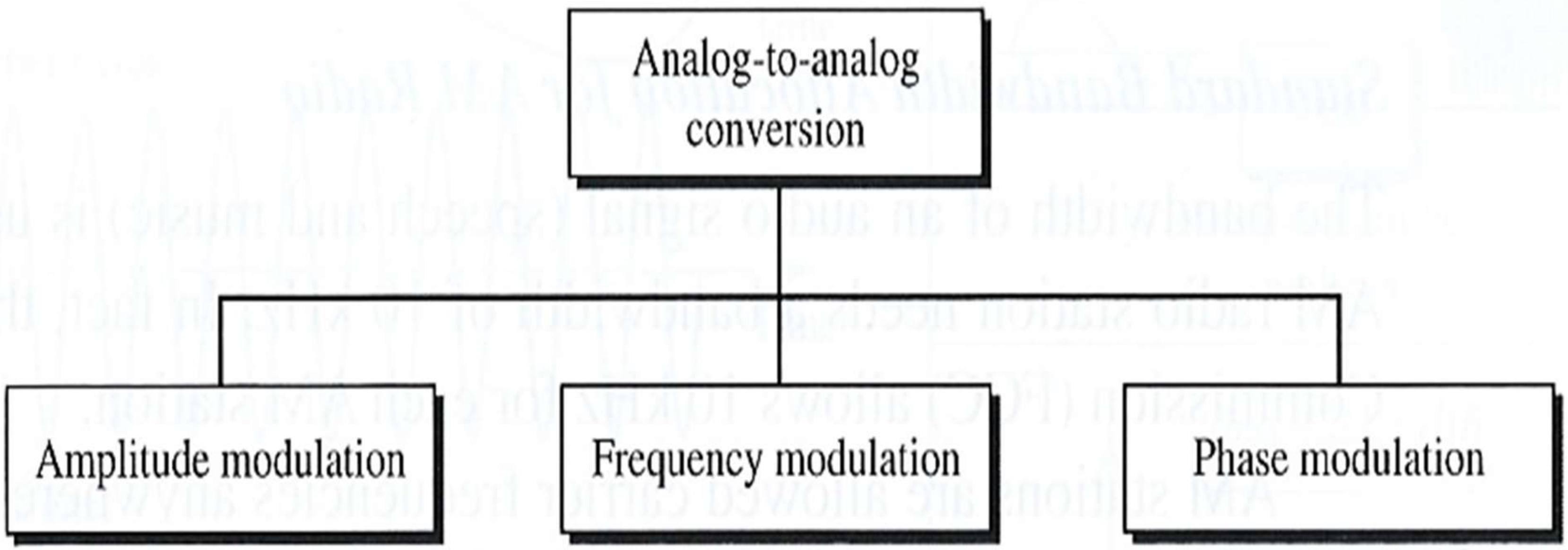
Signal Encoding Techniques

Analog-To-Analog Conversion

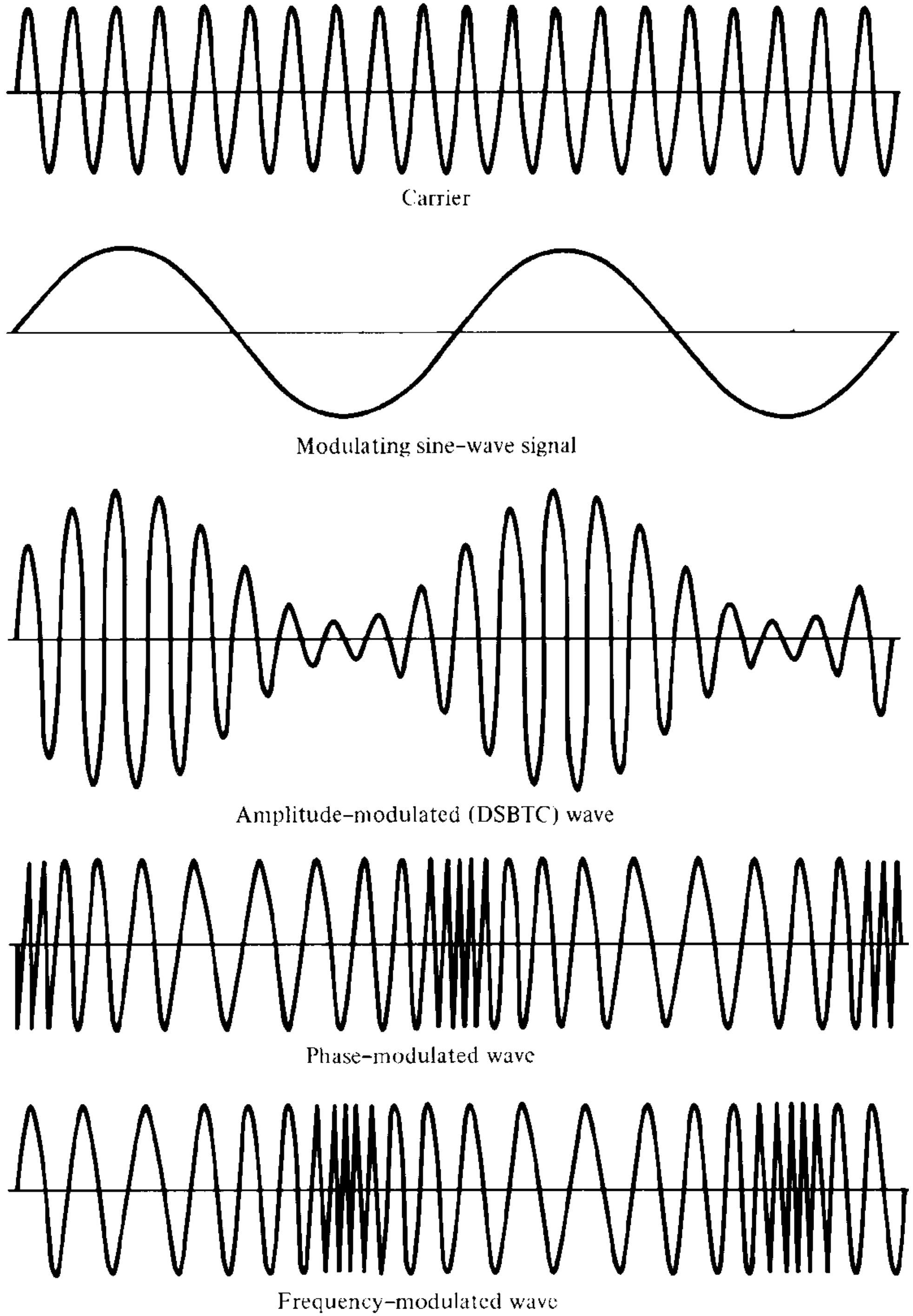
Analog Data, Analog Signals

- Why modulate analog signals?
  - Higher frequency can give more efficient transmission
  - Permits frequency division multiplexing
  - Types of modulation
  - Amplitude
  - Frequency
  - Phase

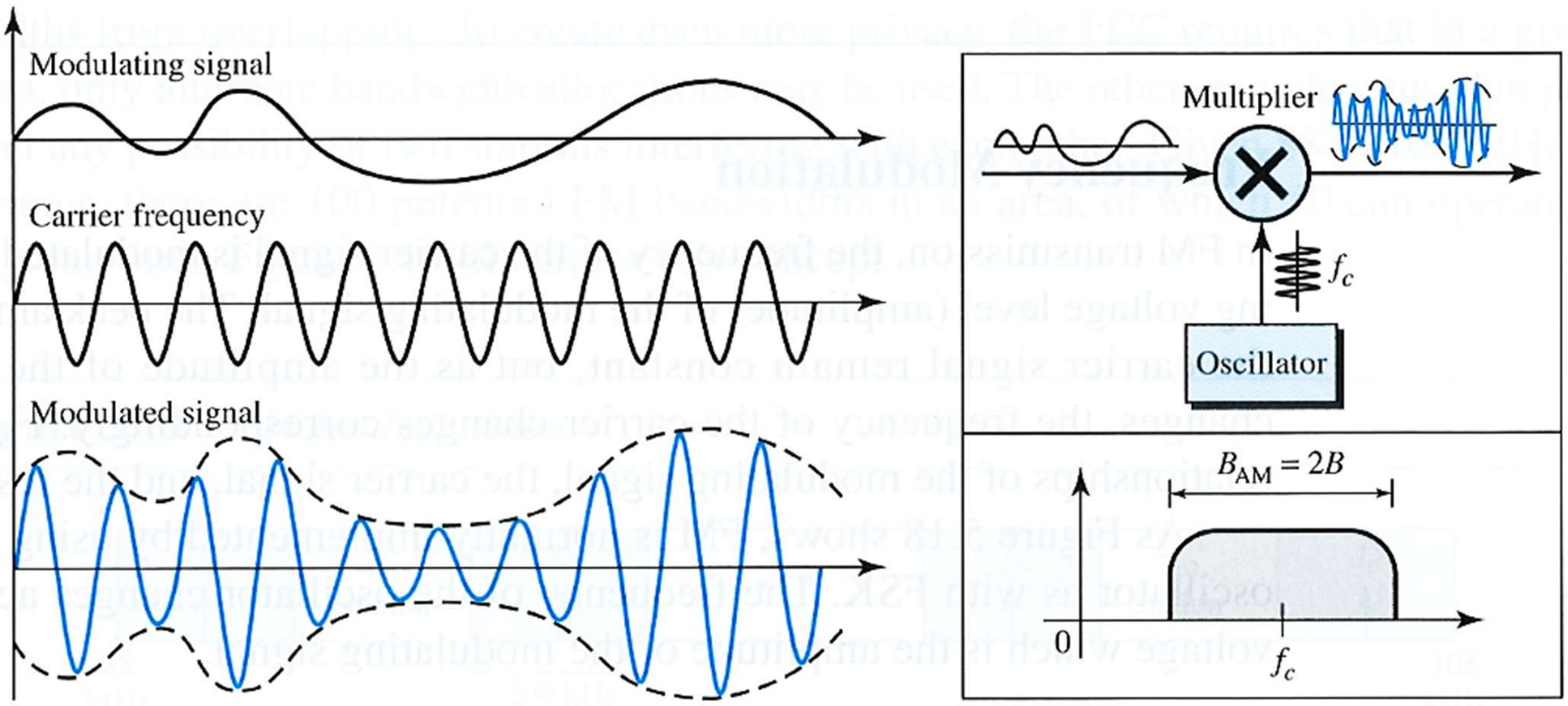
Types of analog-to-analog modulation



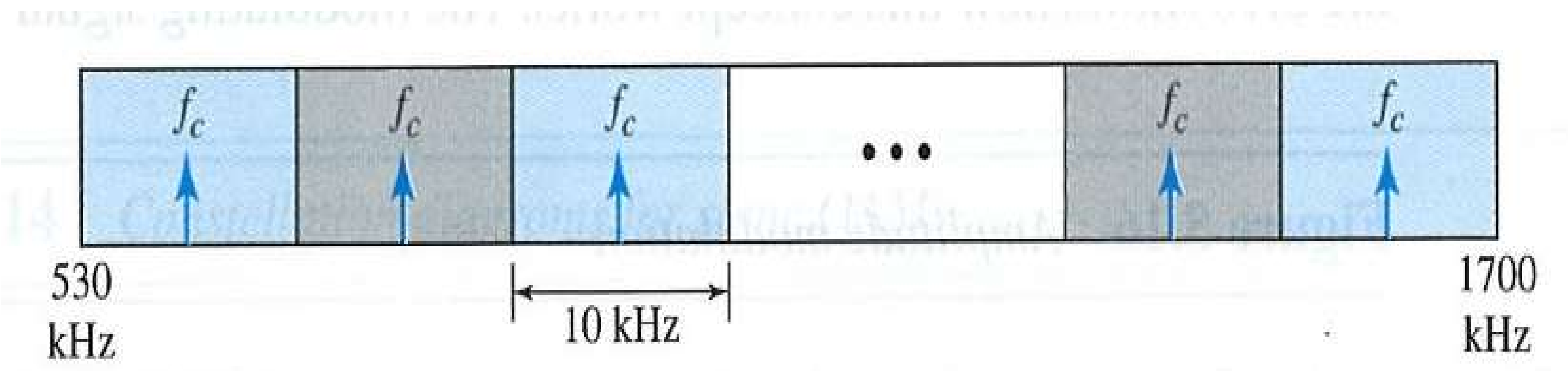
Analog Modulation



Amplitude modulation



AM band allocation



Amplitude modulation with Matlab coding

- %AM_lineSpec.m
- clear all; close all;
- f0= 1; %Fundamental Freq. (Natural Freq.)
- P= 6; %Period of signal
- %objSinusoid; %call function to generate all sinusoid waveforms
- T= 0.005; % Time spacing
- fs= 1/T; %Sampling freq.
- t= [0:T:(P-T)]; %Time axis, vector
- N= length(t); % length of signal waveform
- fm= 1; %Message Freq.
- fc= 20; %Carrier Freq.
- crr = cos(2*pi*fc*f0*t); anlgDat = cos(2*pi*fm*f0*t);
- am=(1/2)*(cos(2*pi*(fc+fm)*f0*t)+cos(2*pi*(fc-fm)*f0*t));
- figure; subplot(311);plot(t,anlgDat); ylabel('Modulating Signal');
- subplot(312);plot(t,crr); ylabel('Carrier');
- subplot(313);plot(t,am); ylabel('Modulated Signal');

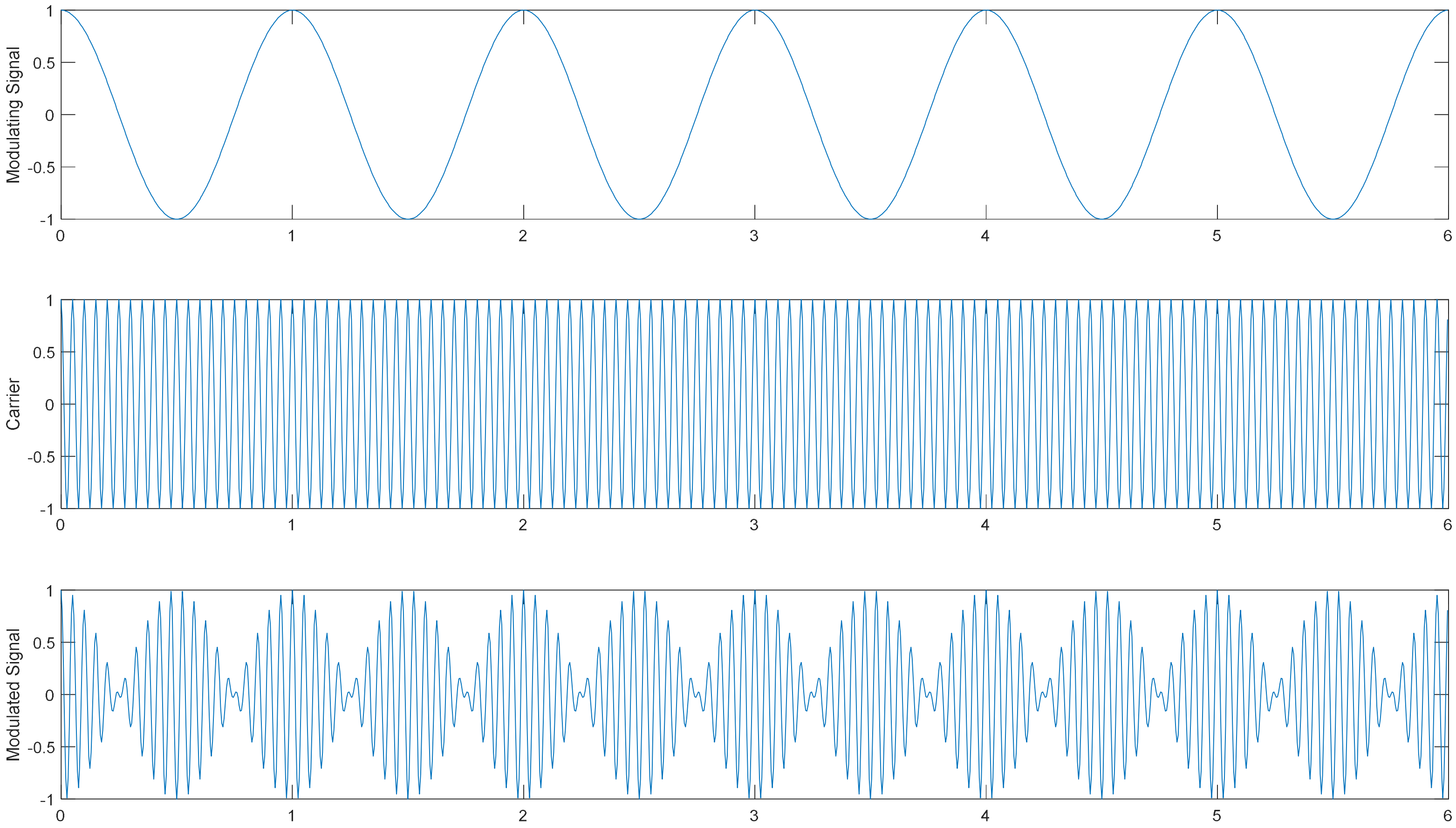
Amplitude modulation with Matlab coding

- %Line Spectrum Estimation
- sigAll= [anlgDat; crr; am];
- [fd, f, mag]= doubSpec(sigAll,T); %call doubleSpectrum function!
- figure; subplot(311); plot(f, mag(1,:));
- title('\bf Line Spectrum of All Simulated Sinusoids');
- xlabel('\bf Frequency in Hz'); ylabel('\bf Magnitude, Arb. unit');
- subplot(312); stem(f, mag(2,:));
- subplot(313); plot(f, mag(3,:));
- mgdbShft= fftshift(mag); % Shifting Spectrum around freq. axis
- fsR= [0:fd:(N/2-1)*fd];
- fsL= [(-(N/2-1):1:0)*fd];
- fdbShft= [fsL fsR];
- figure,plot(fdbShft,mgdbShft);
- title('\bf Shifted Mag. Spec.');
- xlabel('\bf Frequency in Hz'); ylabel('\bf Magnitude, Arb. unit');

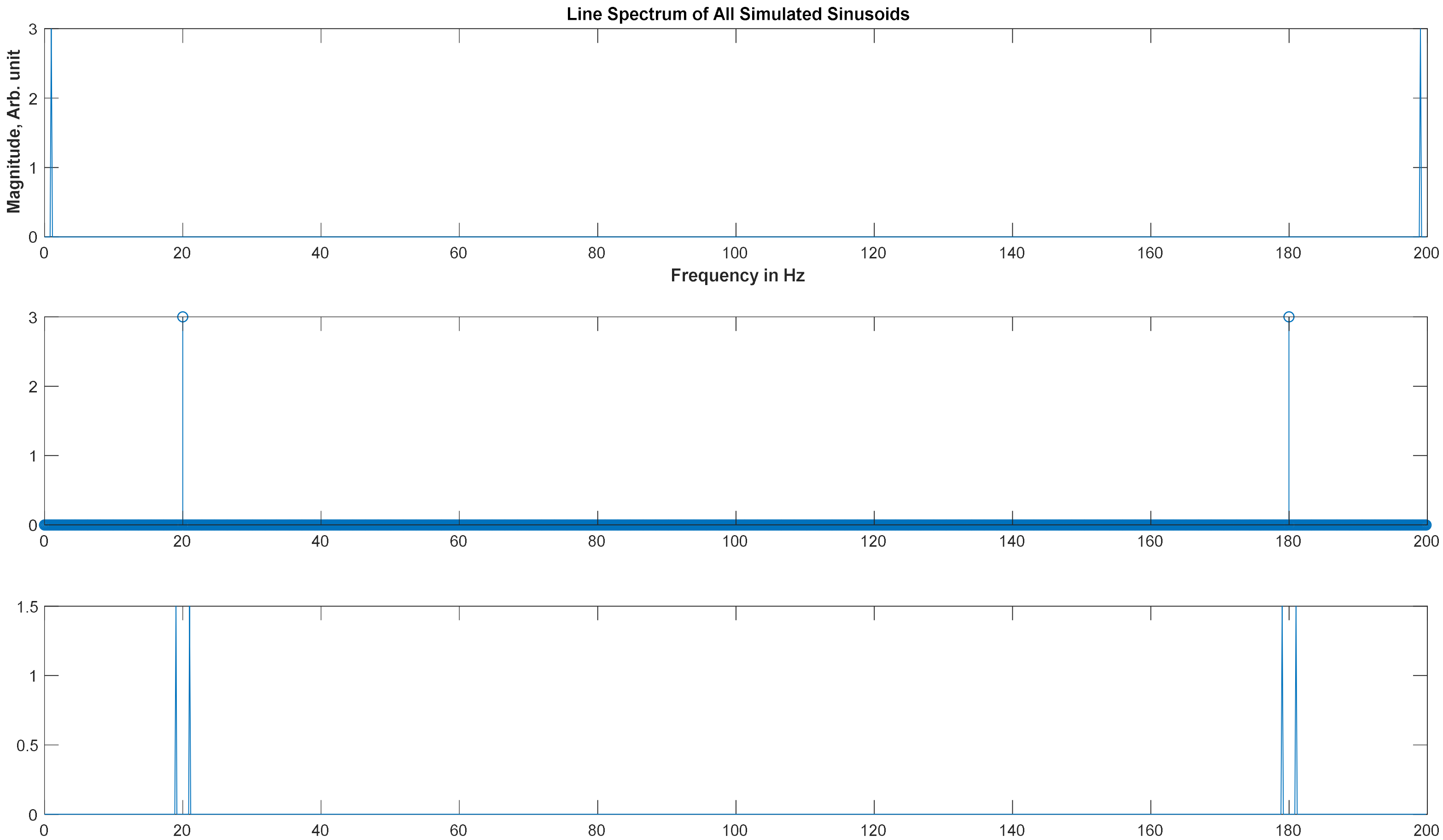
Amplitude modulation with Matlab coding

- function [fd, f, mag]= doubSpec(signal,T)
- N= length(signal);
- fd= 1/(N*T);
- f= [0:fd:(N-1)*fd];
- [M, N]= size(signal);
- mag= [];
- for i= 1:M
-     Y= T*fft(signal(i,:)); %Fourier Transform of signal
-     MY= abs(Y);
-     MYdb= MY(1:N); %Only the first half b/c the remainder is redundant
-     mag= [mag; MYdb];
- end

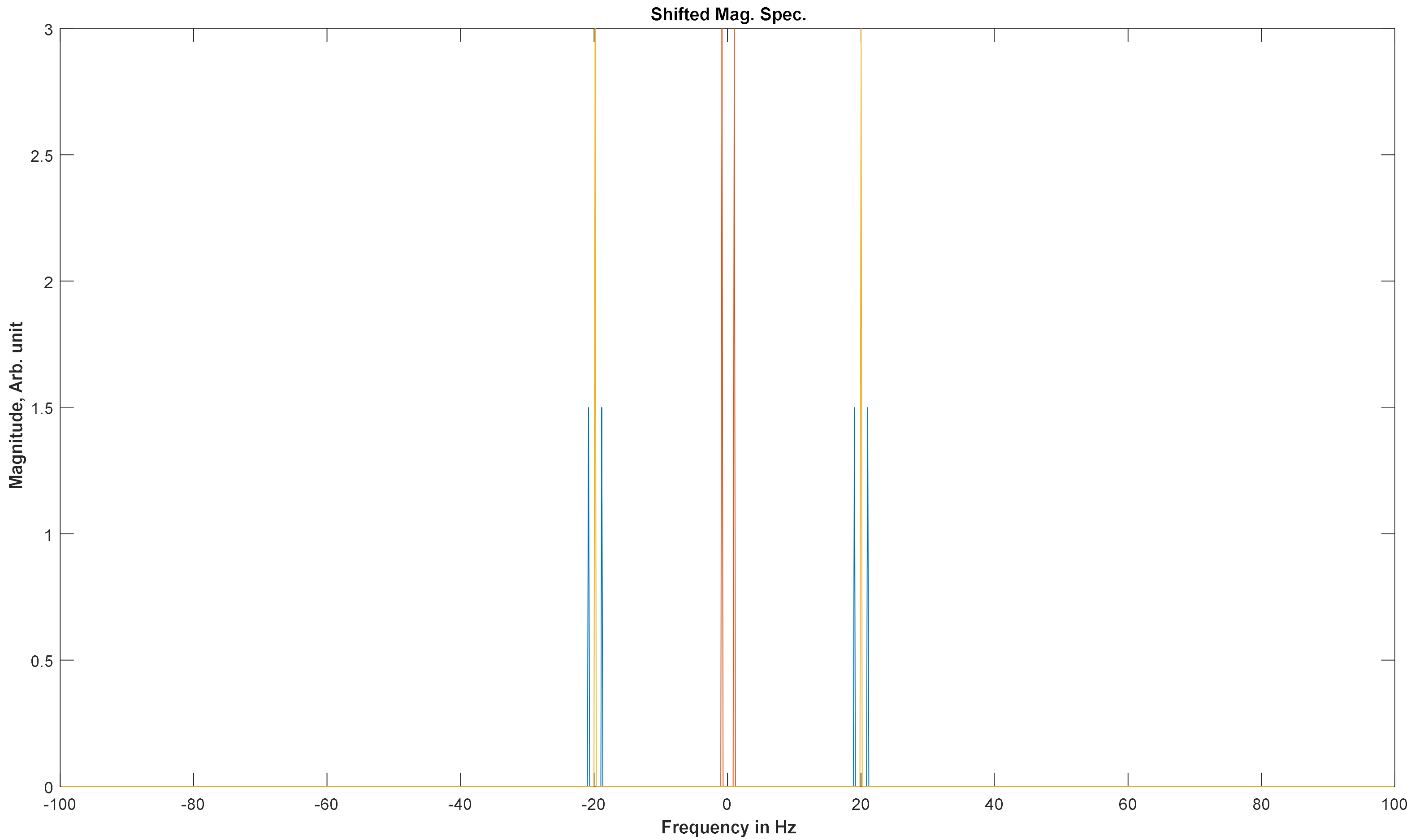
Amplitude modulation with Matlab coding



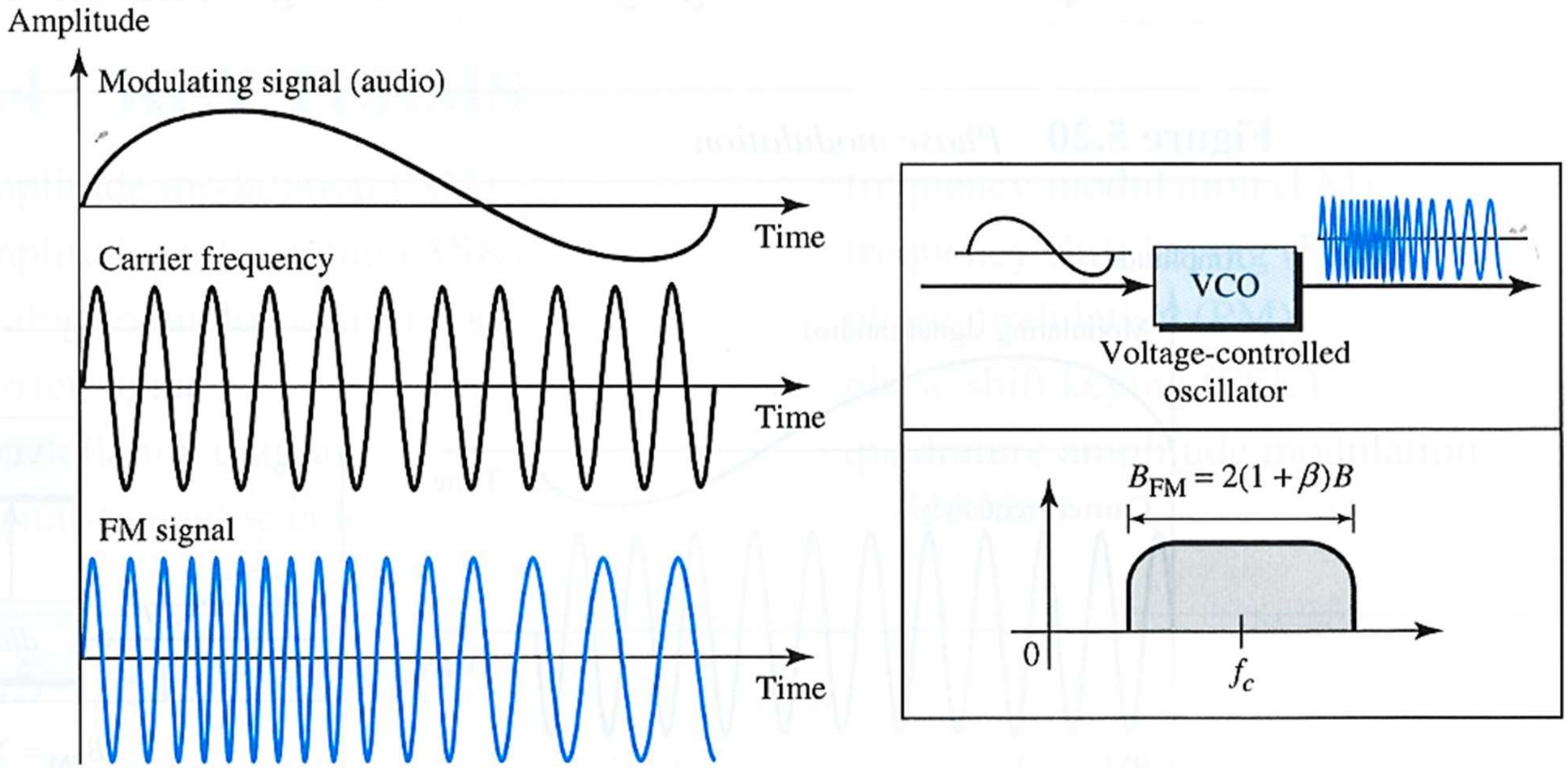
Amplitude modulation with Matlab coding



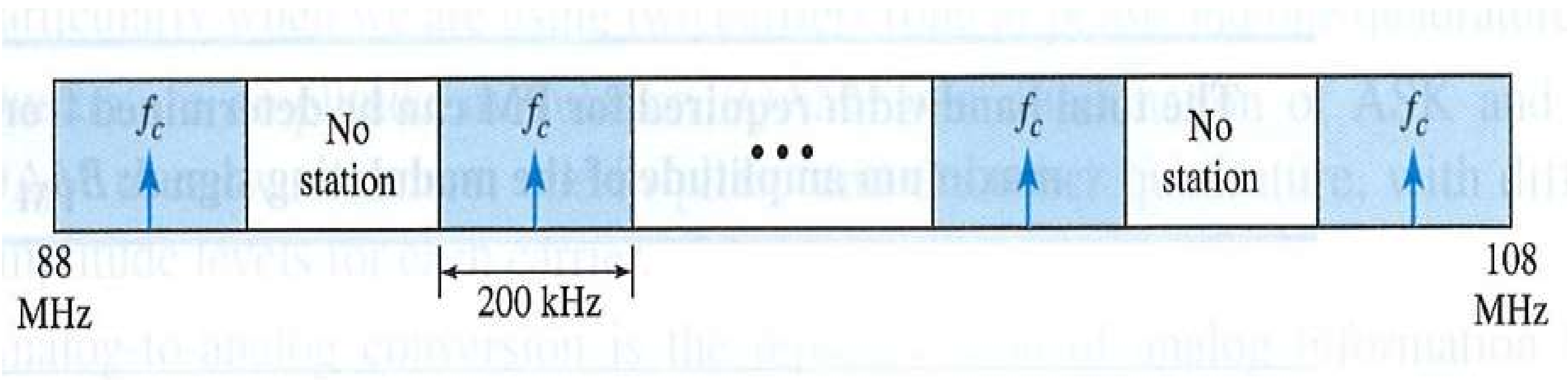
Amplitude modulation with Matlab coding



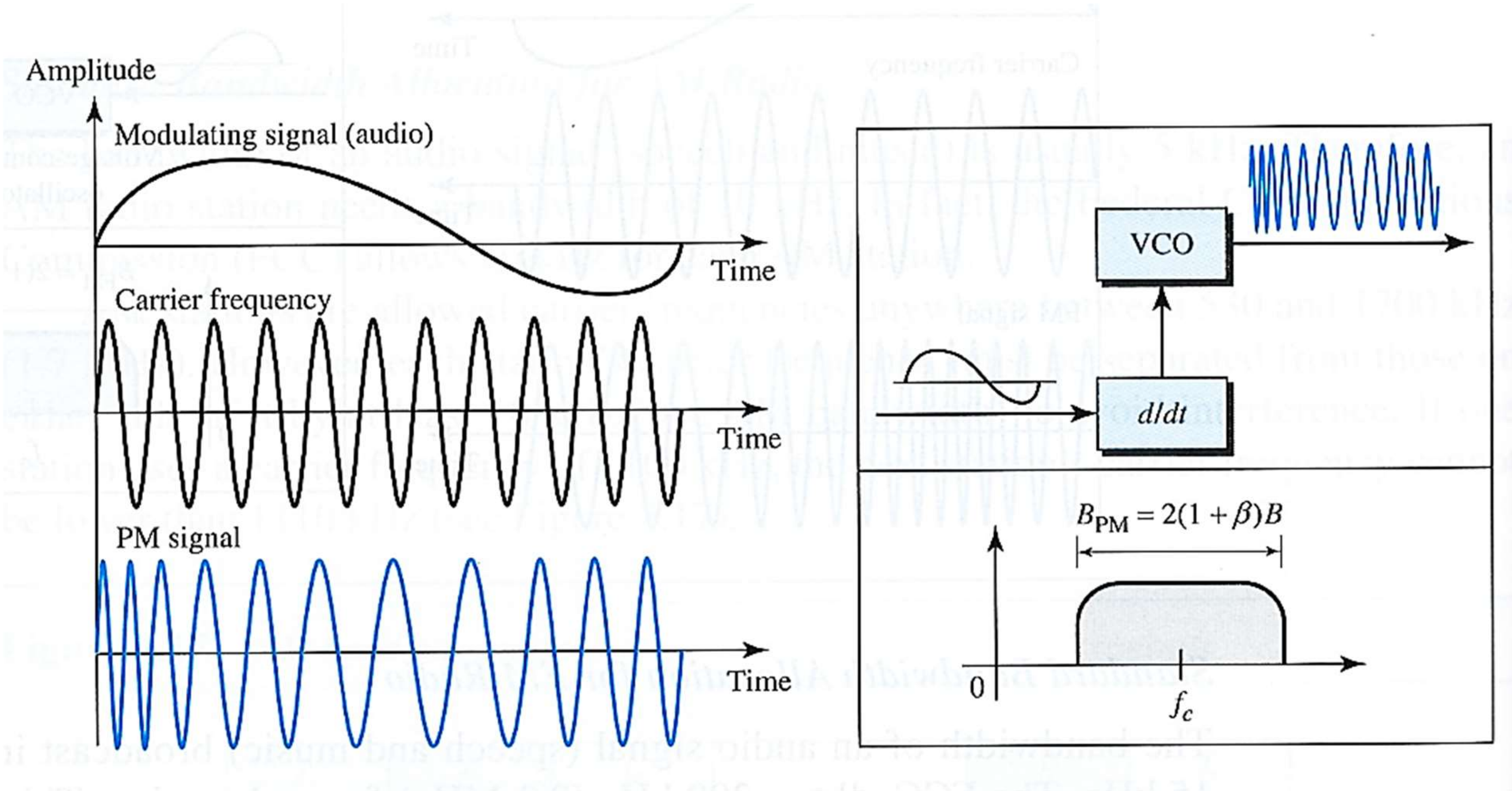
Frequency modulation



FM band allocation



Phase modulation



Summary

- In AM transmission, the carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal. The frequency and phase of the carrier remain the same; only the amplitude changes to follow variations in the information.
- In FM transmission, the frequency of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal. The peak amplitude

Summary

and phase of the carrier signal remain constant, but as the amplitude of the information signal changes, the frequency of the carrier changes correspondingly.

- In PM transmission, the phase of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal. The peak amplitude and frequency of the carrier signal remain constant, but as the amplitude of the information signal changes, the phase of the carrier changes correspondingly.