AM MODULATION WITH MATLAB

ECE 321 – PRINCIPLES OF COMMUNICATION

Tueday, 02 December 2025

DSB SUPPRESSED CARRIER MODULATION

1. **Double Sideband (DSB) Modulation** generates two frequency-shifted copies of a modulated signal on either side of a carrier frequency.

2. DSB is defined by the function

$$f(n) = m(n)cos\left(2\pi f_c \frac{n}{f_s}\right)$$

where m(n) is the message signal, f_s is the sampling frequency and f_c is the carrier frequency

SPECTRUM OF DSB SIGNAL

Since, DSB modulation involves multiplying the message signal m[n] by the carrier $cos\left(2\pi f_c \frac{n}{f_s}\right)$, we can use the modulation theorem of Fourier transforms to calculate the transform of f[n] as:

$$F(f) = \frac{1}{2}[M(f - f_c) + M(f + f_c)]$$

where M(f) is the Discrete-time Fourier Transform (DTFT) of m[n].

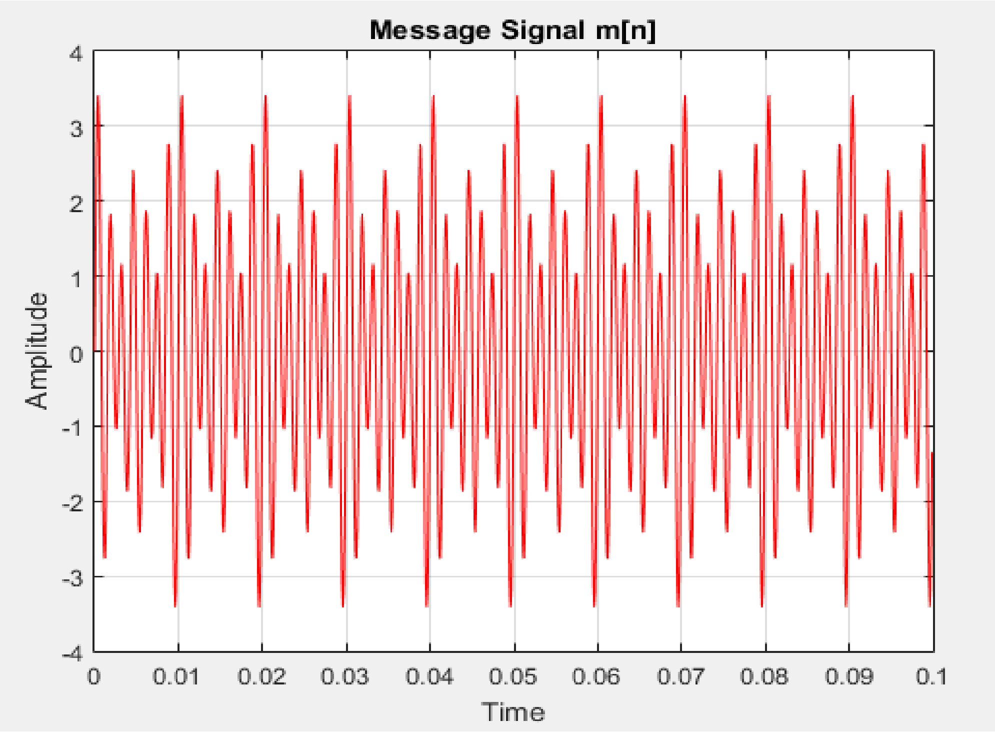
DSB MODULATION EXAMPLE IN MATLAB/01

STEPS

1. Set the sampling rate at 1,000
2. Create and plot a message signal which contains three tones at 50, 60, and 70 Hz with amplitudes 1.0, 0.5 and 2.0 respectively.

MATLAB CODE

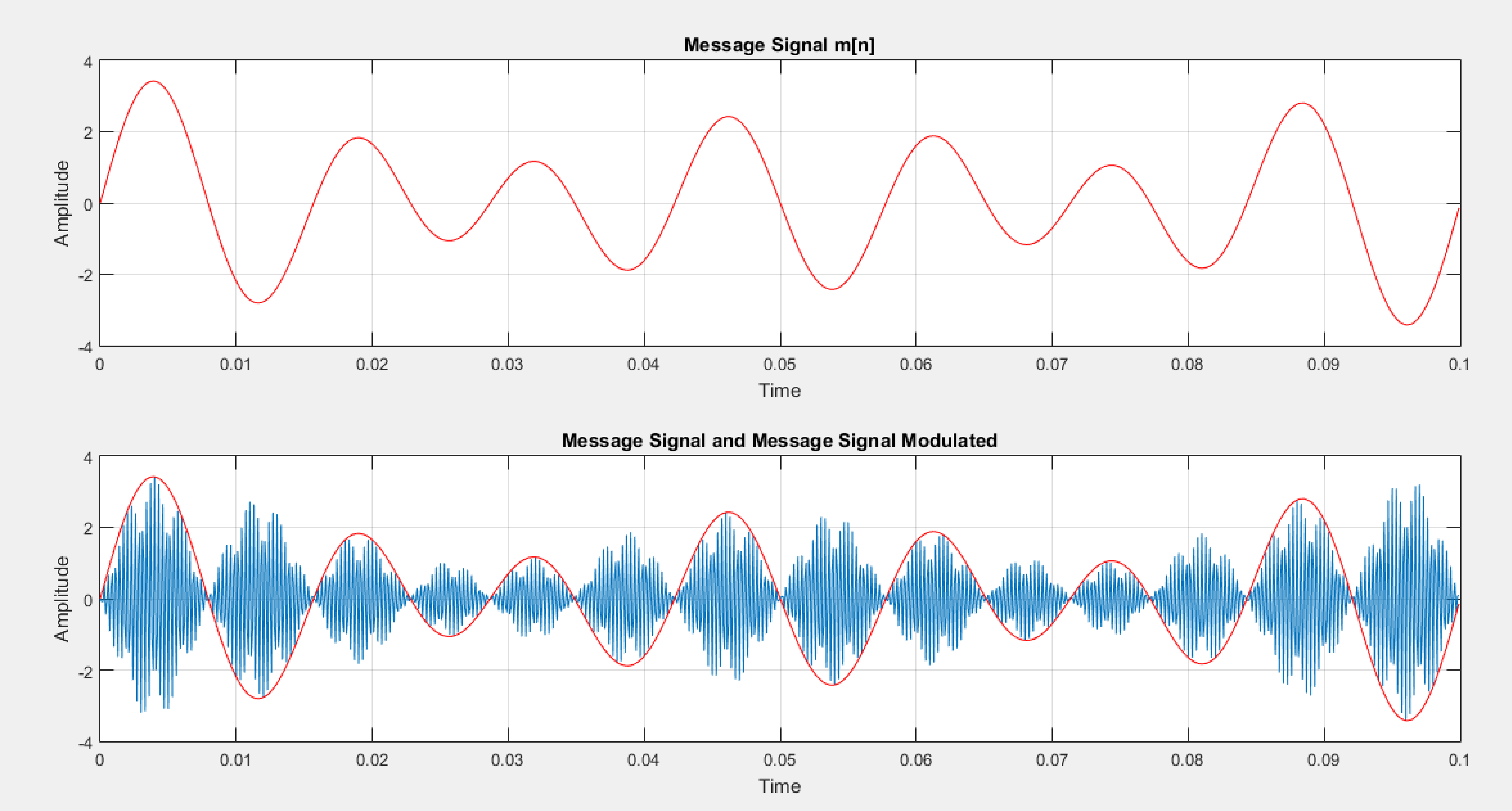
```
fs = 10e3;
t = 0: 1/fs : 0.1-1/fs;
m = sin(2*pi*50*t) + .5*sin(2*pi*60*t) + 2*sin(2*pi*70*t);
subplot(2,1,1);
plot(t,m,'r');
grid
xlabel('Time')
ylabel('Amplitude')
title('Message Signal m[n]')
```



DSP EXAMPLE IN MATLAB/02

MATLAB CODE (CONTINUED)

```
fc = 3.5e3;
f = m.*cos(2*pi*fc*t);
idx = 1000;
subplot(2,1,2);
plot(t(1:idx),f(1:idx),t(1:idx),m(1:idx),'r');
grid
xlabel('Time')
ylabel('Amplitude')
title('Message Signal and Modulated Signal
Modulated')
```


Message Signal m[n]
4
2
0
-2
-4
Amplitude
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Time
Message Signal and Message Signal Modulated
4
2
0
-2
-4
Amplitude
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Time

MATLAB CODE FOR DISPLAYING DSP SIGNAL & SPECTRUM /01

```
fs = 1000;
t = 0:1/fs:1-1/fs;
m = sin(2*pi*50*t) + 0.5*sin(2*pi*60*t) + 2.0*sin(2*pi*70*t);
subplot(3,1,1);
idx = 500;
plot(t(1:idx),m(1:idx),'r');
grid
xlabel('Time')
ylabel('Amplitude')
title('Message Signal m[n]')
fc = 3.5e2;
f = m.*cos(2*pi*fc*t);
subplot(3,1,2);
plot(t(1:idx),f(1:idx),t(1:idx),m(1:idx),'r');
grid
```

MATLAB FOURIER TRANSFORM FUNCTIONS

Matlab functions Y = fft(x) and y = ifft(X) implement the discrete Fourier transform and inverse transform pair given for vectors of length N by:

$$X(k) = \sum_{j=1}^{N} x(j)\omega_N^{(j-1)(k-1)}$$

$$x(j) = \frac{1}{N}\sum_{k=1}^{N} X(k)\omega_N^{-(j-1)(k-1)}$$

Where

$$\omega_N = e^{-2\pi i/N}$$

MATLAB CODE FOR DISPLAYING DSB SIGNAL & SPECTRUM /02

```
xlabel('Time')
ylabel('Amplitude')
title('Message Signal and Message Signal Modulated')
N=1000;
k=1:N/2;
F=fft(f);
M=fft(m);
magF=abs([F(1)/N,F(2:N/2)/(N/2)]);
magM=abs([M(1)/N,M(2:N/2)/(N/2)]);
subplot(3,1,3);
plot(k,magF,k,magM,'r');
title('Spectrum')
```

fft(x)
returns the discrete Fourier transform (DFT) of vector x, computed with a fast Fourier transform (FFT) algorithm.

MATLAB CODE FOR DISPLAYING DSB SIGNAL & SPECTRUM /03