

# AM MODULATION WITH MATLAB

EEEN462 – ANALOGUE COMMUNICATION

Friday, 04 October 2024

# 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  $m[n]$ .

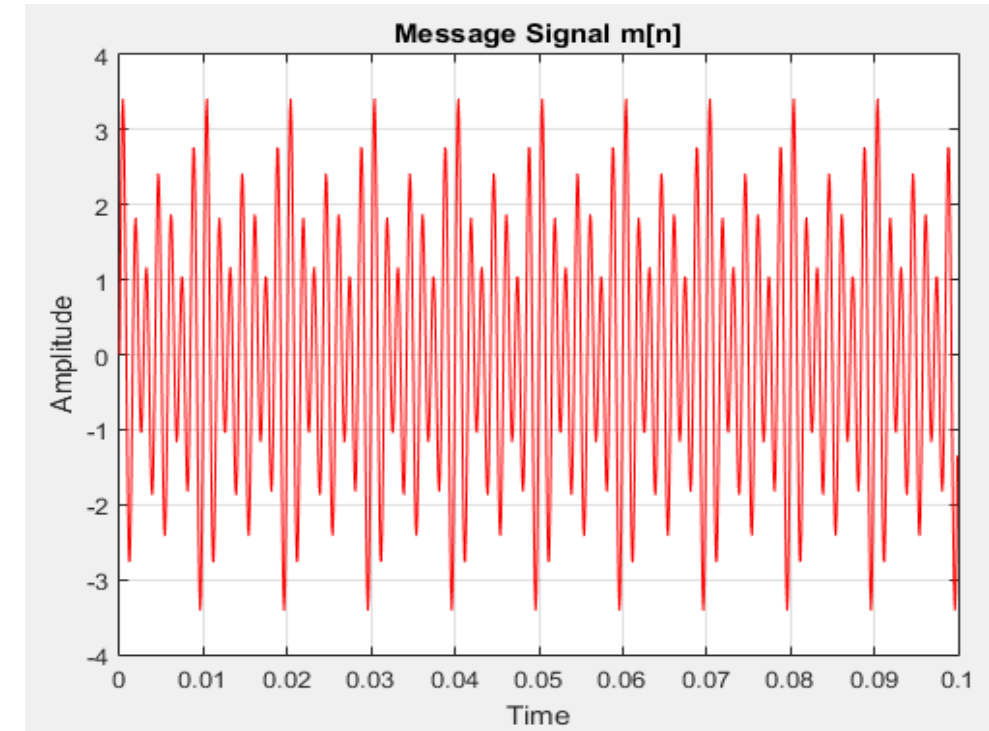
# DSB EXAMPLE IN MATLAB/01

## 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

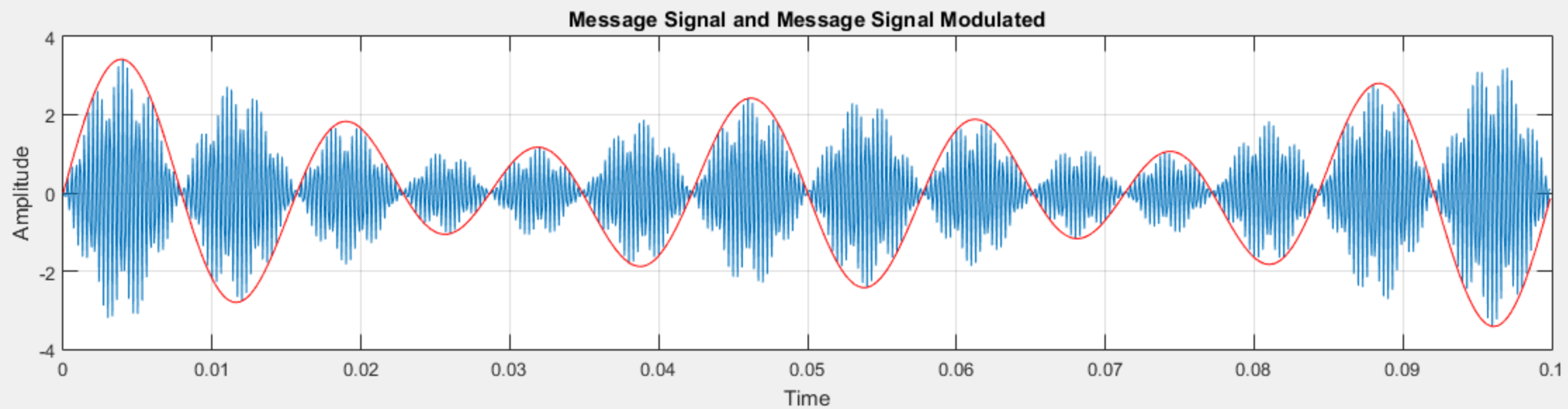
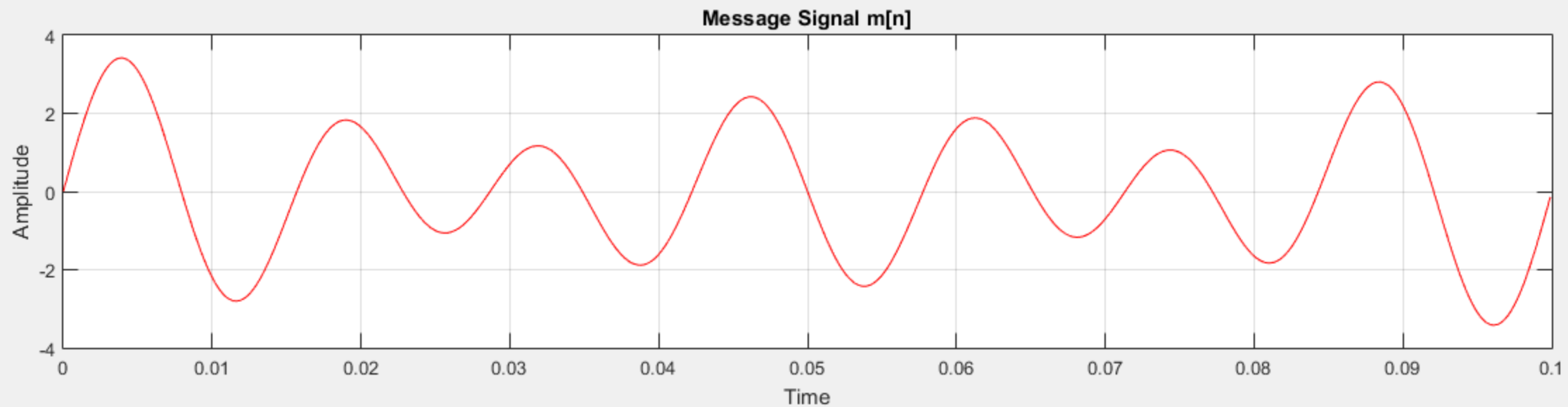
```
fs = 10e3;  
t = 0: 1/fs : 0.1-1/fs;  
m = sin(2*pi*50*t) + .5*sin(2*pi*60*t) + 2*sin(2*pi*70*t);  
subplot(2,1,1);  
plot(t,m,'r');  
grid  
xlabel('Time')  
ylabel('Amplitude')  
title('Message Signal m[n]')
```



# 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 Message Signal  
Modulated')
```



# 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  $Y = \text{fft}(x)$  and  $y = \text{ifft}(X)$  implement the discrete Fourier transform and inverse transform pair given for vectors of length  $N$  by:

$$X(k) = \sum_{j=0}^{N-1} x(j) \omega_N^{(j-1)(k-1)}$$
$$x(j) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) \omega_N^{-(j-1)(k-1)}$$

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

