2EC403 Communication Systems
Special Assignment

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➢ Objective

The objective of this Special Assignment (2EC403 Communication Systems) is to review how to access Matlab. Simulink, and it's varies toolbox like communication toolbox etc., and to become familiar with the basic operations of varies applications and Simulink model.

➢ Introduction to MATLAB

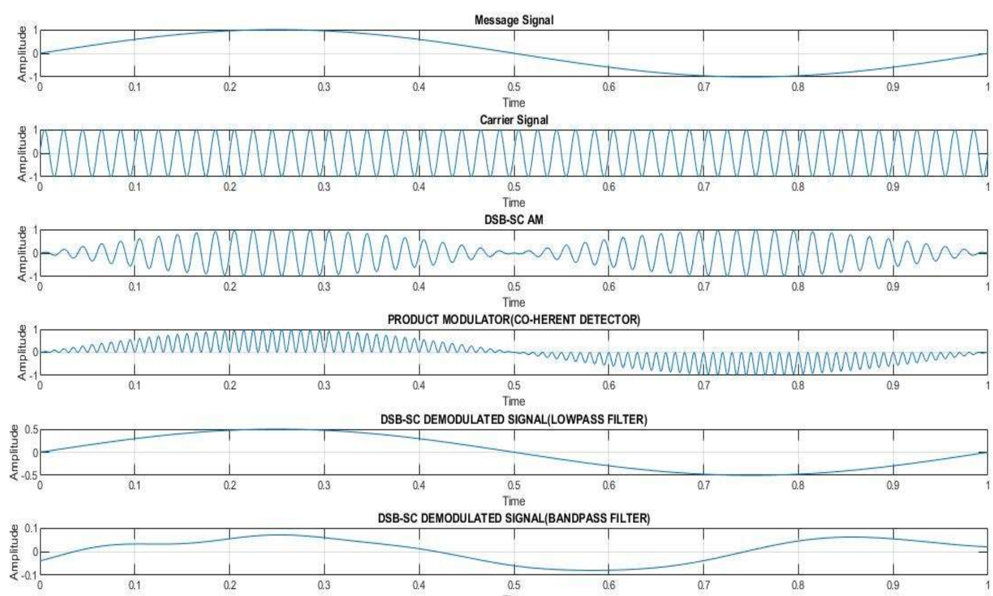
The emphasis of MATLAB is "learning by doing". The name MATLAB stands for MATrix LABoratory. MATLAB is a high-performance language for technical computing. It is a computing environment specially designed for matrix computations, visualization, and programming environment. it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research. It is widely used for the study of a variety of applications, including circuits, signal processing, control systems, communications, image processing, symbolic mathematics, statistics, neural networks, wavelets, and system identification. Its large library of built-in functions and toolboxes, as well as its graphical capabilities, make it a valuable tool for engineering education and research. Matlab has an interactive mode in which user commands are interpreted immediately as they are typed. Alternatively, a program (called a script) can be written in advance using a text editor, saved as a file, and then executed in Matlab.

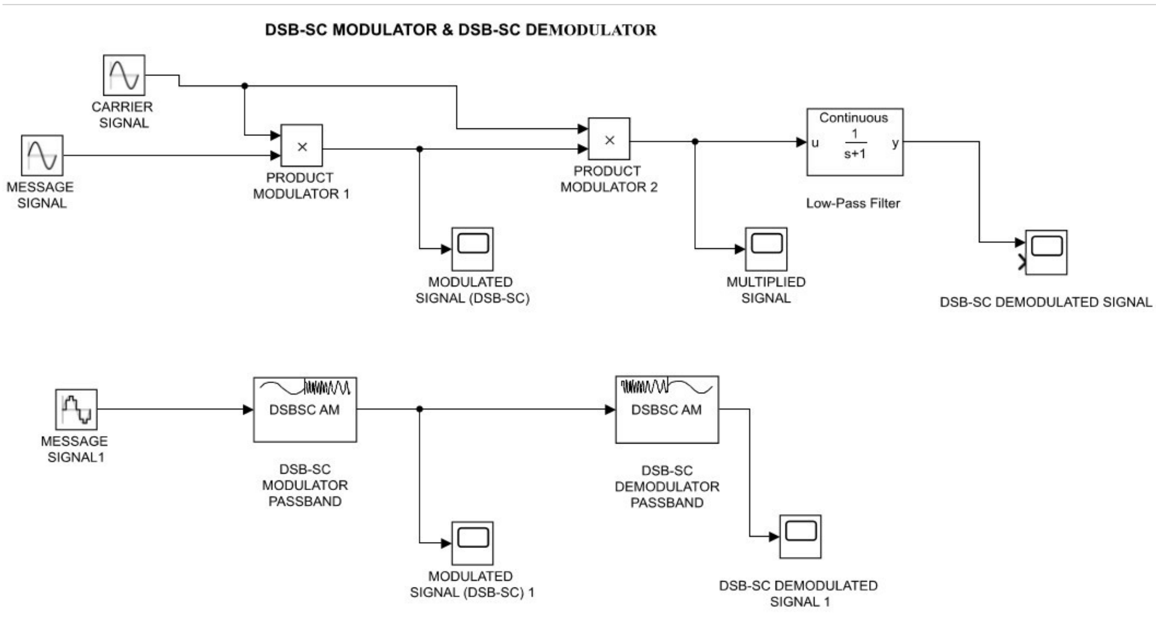
➢ MATLAB codes and Simulink blocks

1. Model a DSB-SC AM system using Simulink and MATLAB. The message signal is 1-Hz sine wave and the carrier frequency is selected as 20 Hz. The sample time parameter value of 1/1000 is used. The parameters of simulation including message signal frequency, carrier frequency, and sampling rate are set up by a companion MATLAB m-file. The m-file also computes the transfer function of the BP and LP filters in the DSB-AM coherent demodulator.

```
fm = input('Enter frequency of message signal ');
fc = input('Enter frequency of carrier signal ');
Am = input('Enter Amplitude of message signal ');
Ac = input('Enter Amplitude of carrier signal ');
fs = input('Enter Sampling period ');
q = input('Enter Phase difference in Local Signal at
           Demodulator Side ');
t = 0:1/fs:1;        % Time Period

% MESSAGE SIGNAL
Em = Am.*sin (2.*pi.*fm.*t);    % MESSAGE SIGNAL
subplot (611);
plot(t,Em)
xlabel('Time');
ylabel('Amplitude');
title('Message Signal');

% CARRIER SIGNAL
Ec=Ac.*sin(2.*pi.*fc.*t);    % CARRIER SIGNAL
subplot(612);
plot(t,Ec)
xlabel('Time');
ylabel('Amplitude');
title('Carrier Signal');

% DSB-SC MODULATION
s=Em.*Ec                     % DSB-SC MODULATED SIGNAL
subplot(613);
plot(t,s)
xlabel('Time');
ylabel('Amplitude');
title('DSB-SC AM');
```

```
% CO-HERENT DETECTOR
% PRODUCT MODULATOR
l=sin((2.*pi.*fc.*t)+q);
v=s.*l
subplot(614);
plot(t,v)
xlabel('Time');
ylabel('Amplitude');
title('PRODUCT MODULATOR(CO-HERENT DETECTOR)');

% LOWPASS FILTER
y=lowpass(v,fm,fs);
subplot(615);
plot(t,y)
xlabel('Time');
ylabel('Amplitude');
title('DSB-SC DEMODULATED SIGNAL(LOWPASS FILTER)');

% BANDPASS FILTER
Z=bandpass(v,[fm (fm+5)],fs);
subplot(616);
plot(t,Z)
xlabel('Time');
ylabel('Amplitude');
title('DSB-SC DEMODULATED SIGNAL(BANDPASS FILTER)');
```

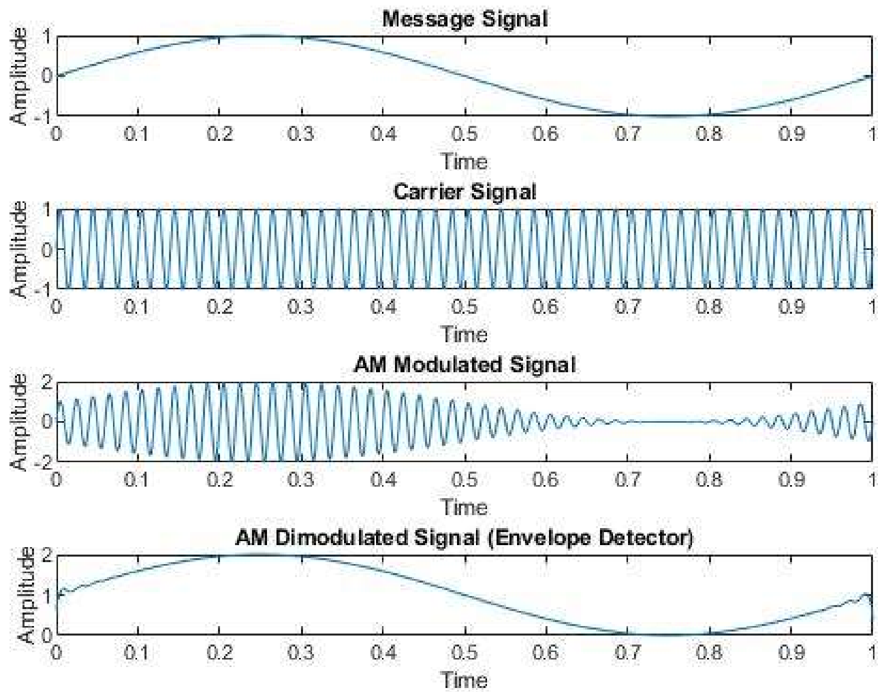


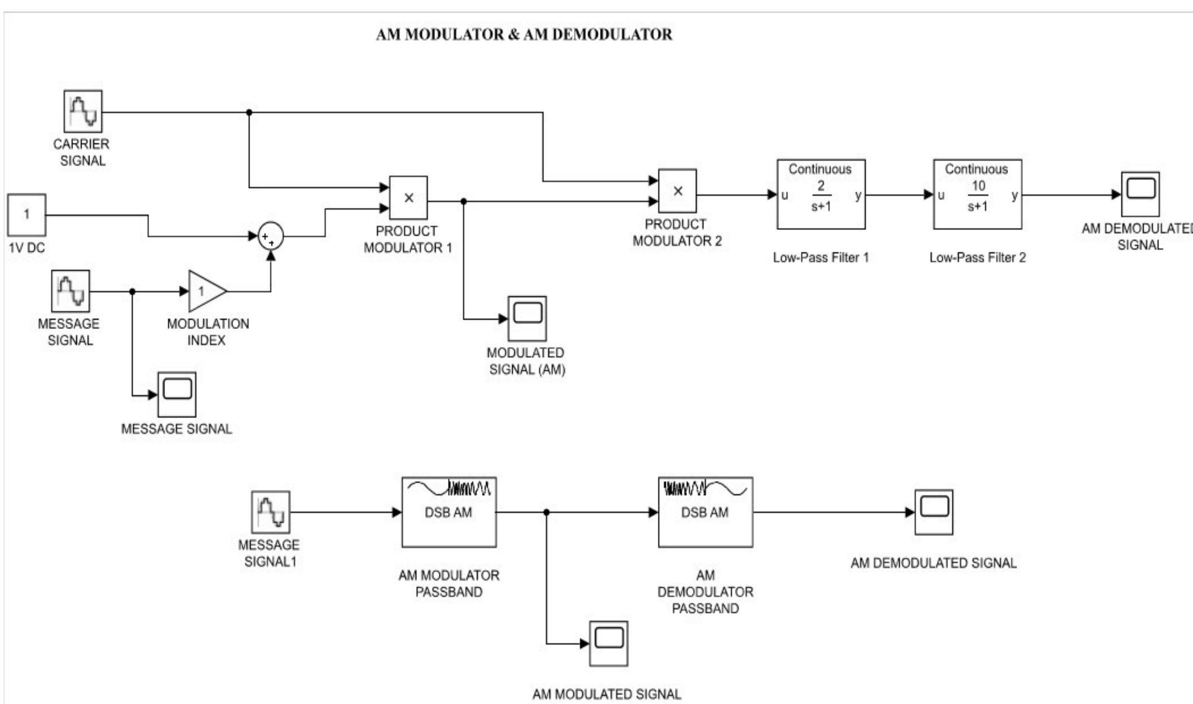


2. Develop a model of a conventional AM system using Simulink and MATLAB.The Message signal is 1.5Hz sine wave and the carrier frequency is selected as 20Hz.The sample time parameter value of 1/1000 is used. The choice of modulation index is made by setting the gain value in the gain block. For this experiment, ma = 0.5 has been selected. The parameters of simulation including message signal frequency, carrier frequency, modulation depth, and Sampling rate are set up by a computation MATLAB m-file. The m-file also computes transfer functions of the BP and LP filters in the AM demodulator using an envelope detector.

```
fm=input('Enter frequency of message signal ');
fc=input('Enter frequency of carrier signal ');
Am=input('Enter Amplitude of message signal ');
Ac=input('Enter Amplitude of carrier signal ');
fs=input('Enter Sampling period ');
t=0:1/fs:1;        % Time Period

% MESSAGE SIGNAL
Em=Am.*sin(2.*pi.*fm.*t);     % MESSAGE SIGNAL
subplot(411);
plot(t,Em)
xlabel('Time');
ylabel('Amplitude');
title('Message Signal');
```

```
% CARRIER SIGNAL
Ec=Ac.*sin(2.*pi.*fc.*t);     % CARRIER SIGNAL
subplot(412);
plot(t,Ec)
xlabel('Time');
ylabel('Amplitude');
title('Carrier Signal');

% AM MODULATION
m=Am/Ac;      % MODULATION INDEX
s=Ac.*(1+(m.*Am.*sin(2*pi*fm*t))).*sin(2*pi*fc*t);
                                        % AM MODULATED SIGNAL
subplot(413);
plot(t,s)
xlabel('Time');
ylabel('Amplitude');
title('AM Modulated Signal');

% AM DEMODULATION
up=envelope(s,300);    % AM DEMODULATED SIGNAL
subplot(414);
plot(t,up)
xlabel('Time');
ylabel('Amplitude');
title('AM Demodulated Signal (Envelope Detector)');
```

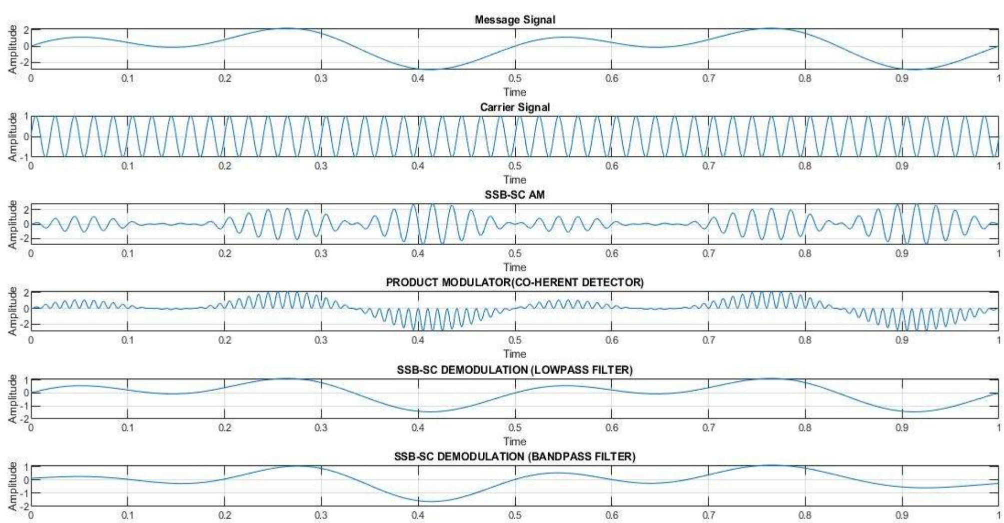

Message Signal
Amplitude
Time
Carrier Signal
Amplitude
Time
AM Modulated Signal
Amplitude
Time
AM Dimodulated Signal (Envelope Detector)
Amplitude
Time

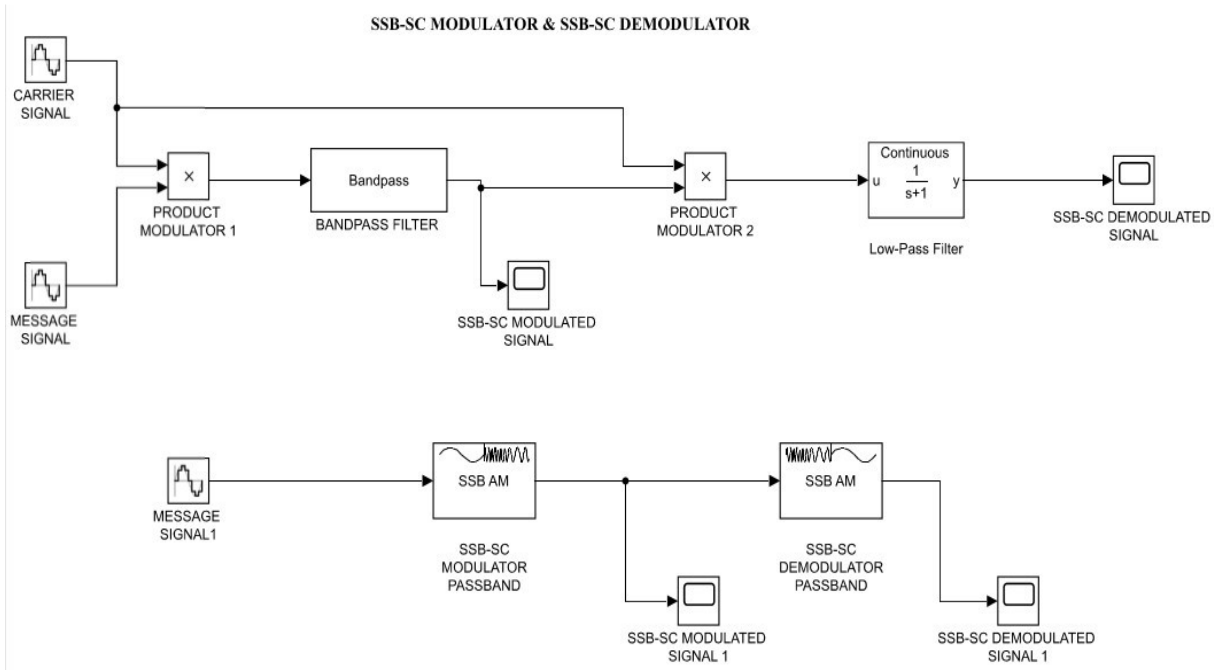

AM MODULATOR & AM DEMODULATOR
CARRIER SIGNAL
1
1V DC
MESSAGE SIGNAL
1
MODULATION INDEX
MESSAGE SIGNAL
PRODUCT MODULATOR 1
MODULATED SIGNAL (AM)
PRODUCT MODULATOR 2
Continuous
2
s+1
Low-Pass Filter 1
Continuous
10
s+1
Low-Pass Filter 2
AM DEMODULATED SIGNAL
MESSAGE SIGNAL1
DSB AM
AM MODULATOR PASSBAND
DSB AM
AM DEMODULATOR PASSBAND
AM DEMODULATED SIGNAL
AM MODULATED SIGNAL

3. Design an SSB-AM system using Simulink and MATLAB.The message signal m (t) =cos (2*pi*t + pi/4).*3 sin (6*pi*t) is used. The carrier frequency is selected as 25Hz.The sample time parameter value of 1/1000 is used. Parameters of simulation including carrier frequency, and sampling rate are set up by a companion MATLAB m-file. The m-file also computes transfer functions of the BP and LP filters in the USB-AM receiver using coherent demodulation.

```
fc=input('Enter frequency of carrier signal ');
Ac=input('Enter Amplitude of carrier signal ');
fs=input('Enter Sampling period ');
q=input('Enter Phase difference in Local Signal at
         Demodulator Side ');
t=0:1/fs:1;    % Time Period

% MESSAGE SIGNAL
m=3.*(cos((2.*pi.*t)+(pi/4)).*sin(6.*pi.*t));  % MESSAGE
                                                 SIGNAL
subplot(611);
plot(t,m)
xlabel('Time');
ylabel('Amplitude');
title('Message Signal');

% CARRIER SIGNAL
Ec=Ac.*sin(2.*pi.*fc.*t);     % CARRIER SIGNAL
subplot(612);
plot(t,Ec)
xlabel('Time');
ylabel('Amplitude');
title('Carrier Signal');

% SSB-SC MODULATION
s=m.*Ec                % DSB-SC MODULATED SIGNAL
w=hilbert(m).*Ec;      % HILBERT TRANSFER FUNCTION
c=(w+s)/2;             % SSB-SC MODULATED SIGNAL
subplot(613);
plot(t,c)
xlabel('Time');
ylabel('Amplitude');
title('SSB-SC AM');
```

```
% CO-HERENT DETECTOR
% PRODUCT MODULATOR
l=sin((2.*pi.*fc.*t)+q);
v=c.*l
subplot(614);
plot(t,v)
xlabel('Time');
ylabel('Amplitude');
title('PRODUCT MODULATOR(CO-HERENT DETECTOR)');

% LOWPASS FILTER
y=lowpass(v,20,fs);
subplot(615);
plot(t,y)
xlabel('Time');
ylabel('Amplitude');
title('SSB-SC DEMODULATION (LOWPASS FILTER)');

% BANDPASS FILTER
Z=bandpass(v,[1 5],fs);
subplot(616);
plot(t,Z)
xlabel('Time');
ylabel('Amplitude');
title('SSB-SC DEMODULATION (BANDPASS FILTER)');
```

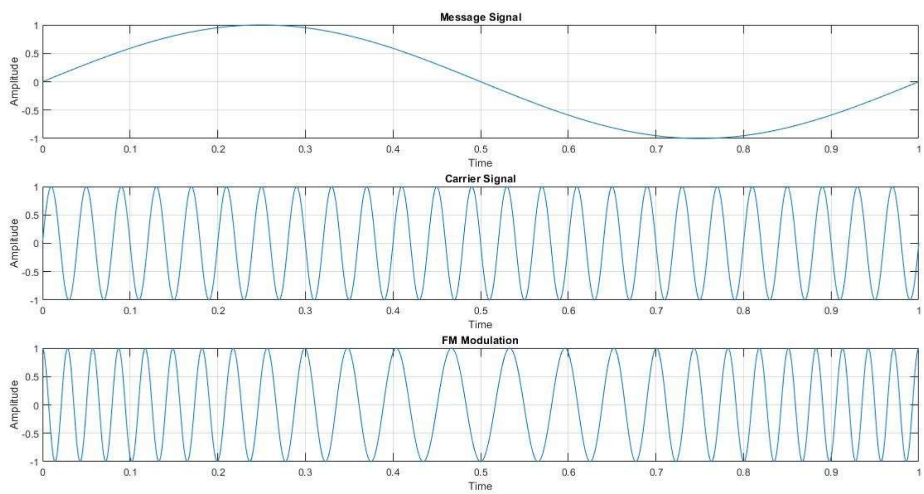




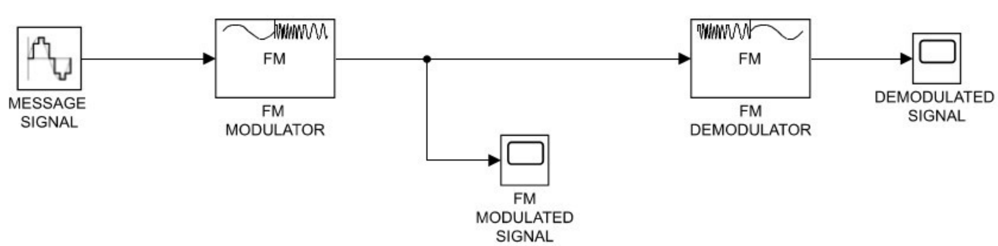
4. Use the Simulink to model FM modulator and demodulator. The parameters of simulation including carrier and message signal frequencies, FM modulator sensitivity, and Low Pass filter are setup by a companion MATLAB m-file. The carrier frequency is 25Hz and the message signal is 1HZ sine wave. The FM modulator sensitivity kf is set at 10 Hz/V. Use the Simulink model for the FM modulator

```
fm=input('Enter frequency of message signal ');
fc=input('Enter frequency of carrier signal ');
Am=input('Enter Amplitude of message signal ');
Ac=input('Enter Amplitude of carrier signal ');
Kf=input('Enter FM modulator sensitivity ');
fs=input('Enter Sampling period ');
t=0:1/fs:1;         % Time Period

% MESSAGE SIGNAL
Em=Am.*sin(2.*pi.*fm.*t);   % MESSAGE SIGNAL
subplot(311);
plot(t,Em)
xlabel('Time');
ylabel('Amplitude');
title('Message Signal');
```

```
% CARRIER SIGNAL
Ec=Ac.*sin(2.*pi.*fc.*t);    % CARRIER SIGNAL
subplot(312);
plot(t,Ec)
xlabel('Time');
ylabel('Amplitude');
title('Carrier Signal');

% FM MODULATION
f=Kf.*Am;       %FREQUENCY DEVIATION
s=Ac.*(cos((2.*pi.*fc.*t)+((f/fm).*sin(2.*pi.*fm.*t))));    %
FM MODULATED SIGNAL
subplot(313);
plot(t,s)
xlabel('Time');
ylabel('Amplitude');
title('FM Modulation');
```



FM MODULATOR & FM DEMODULATOR



➢ CONCLUSION

In Amplitude Modulation (AM), the carrier frequency is constant, on the other hand, the value of the carrier amplitude varies depending on the amplitude of the modulating signal. The envelope of the modulated signal is the same shape as the modulating signal. Modulation index is the ratio of the peak voltage of the modulating signal and the peak voltage of the unmodulated carrier. It is directly proportional to the peak voltage of the modulating signal and inversely proportional to the peak voltage of the carrier signal. From the modulated carrier displayed on an oscilloscope, the percent modulation can be measured through the maximum and the minimum values of the modulating signal, the voltage of each side frequency depends on carrier voltage and the modulation index. The bandwidth is twice the modulating frequency. A square wave which is a complex modulating signal consists of many side frequencies generated.

In radio communications, single-sideband modulation (SSB) or single-sideband suppressed-carrier modulation (SSB-SC) is a type of modulation used to transmit information, such as an audio signal, by radio waves. A refinement of amplitude modulation, it uses transmitter power and bandwidth more efficiently. Amplitude modulation produces an output signal the bandwidth of which is twice the maximum frequency of the original baseband signal. Single-sideband modulation avoids this bandwidth increase, and the power wasted on a carrier, at the cost of increased device complexity and more difficult tuning at the receiver

Frequency Modulation (FM) is an important modulation scheme both because of its widespread commercial use, and because of its simplicity. Frequency modulation can be simplified to angle modulation with a simple integrator.

➢ **References**

- introduction-to-matlab.pdf
- MATLAB Help
- Simulink 7
- https://www.ni.com/en-in/innovations/white-papers/06/frequency-modulation--fm-.html
- https://en.wikipedia.org/wiki/Single-sideband_modulation