In this homework, we study Single Sideband and Vestigial Sideband Modulation.

i) Generate carrier waves \( c_1(n) \) and \( c_2(n) \) with (normalized) frequency \( f_c = 0.25 \):
\[
c_1(n) = \cos(2\pi f_c n) \quad \text{and} \quad c_2(n) = \sin(2\pi f_c n)
\]
for \( n = 1, 2, \ldots, 256 \). Plot the magnitude spectrum of \( c_1(n) \) and \( c_2(n) \) (use \text{abs} and \text{dft} or \text{fft} commands).

ii) Generate a modulating tone signal with frequency \( f_m = 0.05 \):
\[
m(n) = \cos(2\pi f_m n)
\]
Plot \( m(n) \) and its magnitude spectrum.

iii) Design the filter \( H_q(f) \) (lowpass filter to obtain the quadrature component).
Plot the magnitude and phase of \( H_q(f) \). Pass \( m(n) \) through \( H_q(f) \) and obtain the modulated signal \( s(n) = m(n) \cdot c_1(n) - m_q(n) \cdot c_2(n) \), where \( m_q(n) \) is the quadrature component. Plot \( s(n) \) and its magnitude spectrum. Obtain \( s(n) \) with changing the sign \(-\) and plot \( s(n) \) and the spectrum.

iv) Obtain \( x_1(n) = s(n) \cdot c_1(n) \) for both signs \((-\),\(+\)). Plot its magnitude spectrum.

v) Design a LowPass Filter using Matlab’s \textit{fir1} with \( N=8 \) and \( W=0.3 \). Plot the filter’s magnitude response.

vi) Using \text{conv} command lowpass filter \( x_1(n) \) to obtain \( v_1(n) \). Plot \( v_1(n) \) and its spectrum. Comment on the results.

vii) Repeat \( \text{iii),iv),v),vi) } \) for VSB modulation. In order to obtain \( m_q(t) \): a) take Fourier transform of \( m(t) \) to obtain \( M(k) \),
\[
b) \quad \text{Pass } M(k) \text{ through a filter with the transfer function } H(k) = \begin{cases} (k-1)/25 & \text{for } k=1,\ldots,26, \\ 1 & \text{for } k=27,\ldots,128, \\ -1 & \text{for } k=129,\ldots,231 \end{cases} \quad \text{and } H(k) = (k-257)/25 \text{ for } k=232,\ldots,256.
\]
c) Take inverse Fourier transform.

viii) Comment on the results.