4 Labwork

4.1 DSB-SC Modulation and Demodulation

a. Construct a message signal $m(t) = A_m \cos(2\pi f_m t)$ and carrier signal $c(t) = A_c \cos(2\pi f_c t + \theta_c)$ where $A_m = 2$, $f_m = 50$ Hz, $A_c = 1$, $f_c = 1$ kHz and $\theta_c = 0$. The sampling frequency is $F_s = 50$ kHz and the durations of $m(t)$ and $c(t)$ are $d = 0.1$ s.

b. Apply the DSB-SC modulation part for the message signal $m(t)$ as shown in Figure 1.

c. Plot $m(t)$ and $c(t)$ on the same axis in time domain.

d. Plot the modulated signal $s(t)$ in time domain.

e. Apply the demodulation part for $s(t)$ as shown in Figure 1.
   - At first, obtain $u(t)$ where $\theta = 0$. Adjust the magnitude of your signals accordingly.
   - Construct a Butterworth low pass filter by using *butter(.)* function. Choose the appropriate cut-off frequency and filter order to extract the message signal properly.

f. Plot the magnitude responses, $|M(f)|$, $|S(f)|$, and $|U(f)|$ by using 3×1 subplot.

g. Plot $m(t)$ and $y(t)$ on the same axis in time domain.

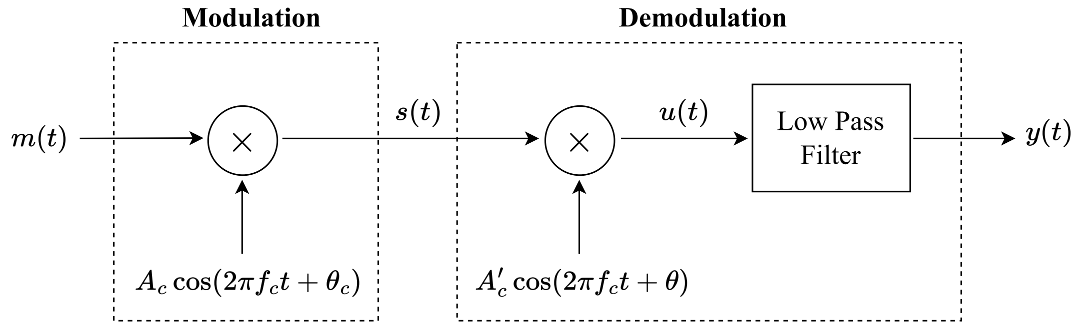

Figure 1: DSB-SC modulation and demodulation.

4.2 SSB Modulation

a. Design a 5^{th} order Butterworth bandpass filter over the frequency range from 1 kHz to 2 kHz.

b. Use this filter to obtain $s_u(t)$ from the DSB-SC signal $s(t)$ that you generated above. See Figure 2.

c. Plot the magnitude response of the filter and $|S_u(f)|$ by using 2×1 subplot.

Figure 2: Generating upper-sideband (USB) signal from a DSB-SC signal.

4.3 Report

Please answer the questions given below in your report. Give clear explanations.

Q1. Consider a message signal $m(t)$ and carrier signal $c(t) = \cos(2\pi f_c t + \theta_c)$ for the DSB-SC modulation and demodulation described in Figure 1.

(a) Write $s(t)$, $u(t)$, and $y(t)$ when $\theta_c = 0$ and $\theta = 0$. What was your adjustment on the magnitude of your signals? Explain clearly.

(b) Write $u(t)$ and $y(t)$ when $\theta_c = 0$ and $\theta = \pi/6$. What happens when $\theta \neq \theta_c$?

Note: $\cos(x)\cos(y) = \frac{1}{2}\left(\cos(x+y) + \cos(x-y)\right)$

Q2. Consider the SSB signal generation shown in Figure 2.

(a) Can the $s_u(t)$ that you obtained in **(4.2.b)** be called as SSB signal? If not, what can it be called? Explain your answer.

(b) Could the $s_u(t)$ be called as SSB signal if the filter were an ideal bandpass filter having the same frequency range? Explain your answer.