COMMUNICATION THEORY, Exercise 5, Fall 2023

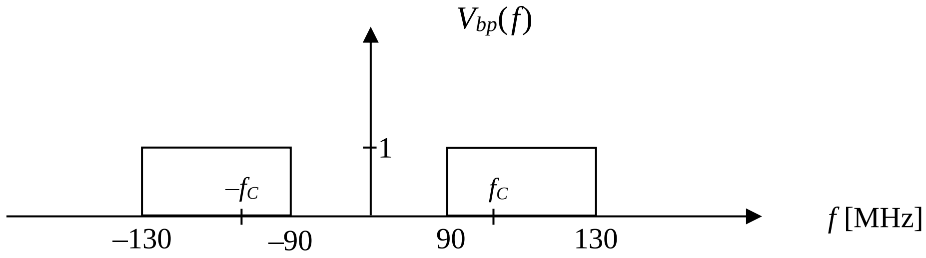
1. A complex lowpass signal $v_{lp}(t)$ can be transformed into a real bandpass signal by doing

$$v_{bp}(t) = Re\left[v_{lp}(t) \cdot e^{j\omega_c t}\right]$$

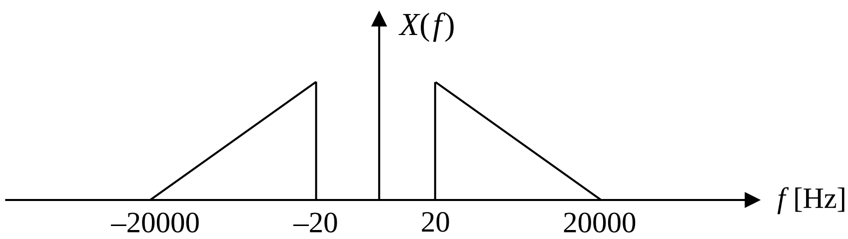
Using only real-valued signals and operations:

a) draw a block diagram for generating the signal $v_{bp}(t)$ from $v_i(t)$ and $v_q(t)$
b) draw a block diagram for extracting $v_i(t)$ and $v_q(t)$ from the signal $v_{bp}(t)$
c) draw the corresponding diagrams using complex signals and operations instead

2. Find the lowpass equivalent $v_{lp}(t)$ and the corresponding I and Q components $v_i(t)$ and $v_q(t)$ for the following bandpass signal $v_{bp}(t)$, given the carrier frequency f_C = 100 MHz.



3. The spectrum of a certain audio signal is shown in the picture below. Draw the spectra of the corresponding AM, DSB, USSB, LSSB, and VSB+C modulated signals using carrier frequency f_C = 95 MHz, and calculate the needed bandwidth in each case.



4. Consider the sideband power P_{SB}, defined as the power in one single side or half of the spectrum (not including a possible carrier in the center), and the maximum instantaneous power A_{max}^2, or the square of the maximum instantaneous amplitude of a signal.

a) Find an expression of the ratio P_{SB} / A_{max}^2 for an AM and a DSB modulated signal, as a function of the baseband signal power S_X

b) Assuming S_X = 0.2 W, calculate the required transmission power S_T and the corresponding maximum instantaneous power A_{max}^2 to achieve P_{SB} = 10 W for AM (with μ = 1) and DSB modulations