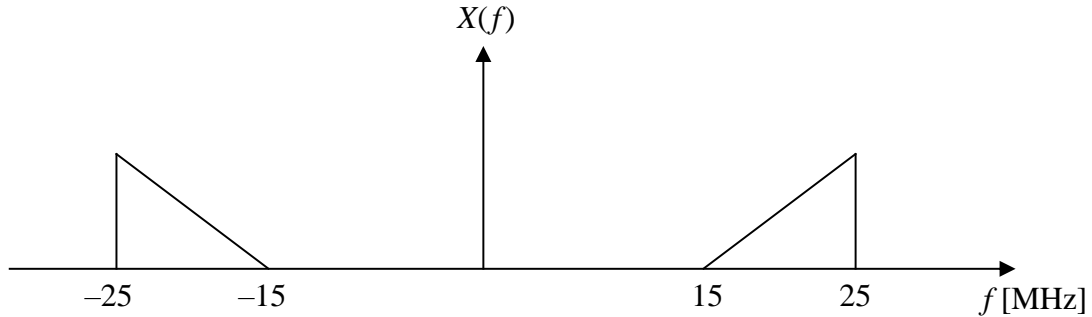# COMMUNICATION THEORY, Exercise 7, Fall 2023

1. Consider a bandpass signal $x(t)$ with a spectrum as in the following picture.

Sketch the spectrum of the sampled signal, resulting from sampling $x(t)$ with ideal pulses, when using the following sampling frequencies, and explain in which of these cases the original signal can be fully reconstructed from the discrete-time samples using filtering.

a) $f_S = 60$ MHz
b) $f_S = 45$ MHz
c) $f_S = 25$ MHz

2. Based on the previous problem, formulate the general sampling rate requirements for alias-free sampling of a bandpass signal with center frequency f_C and bandwidth B.
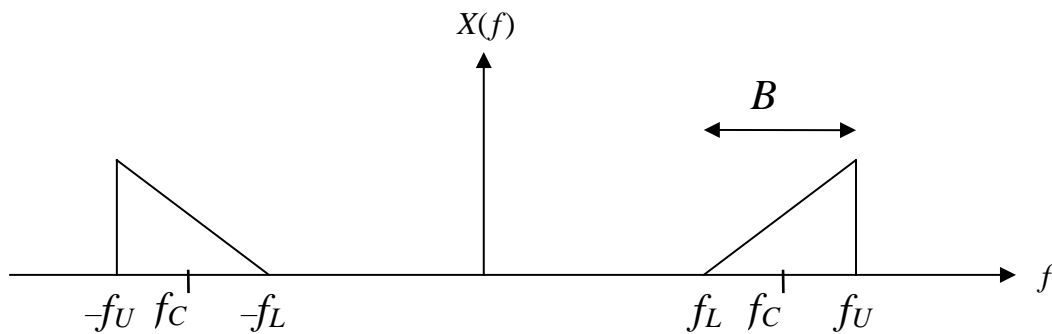
3. A baseband binary PAM signal $x(t)$ is constructed using basic pulse shape:

$$p(t) = \cos^2(\pi t / 2T_b)\, \Pi(t / 2T_b)$$

a) Sketch a picture of the continuous-time signal $x(t)$ when the source data sequence is equal to 1 0 1 1 1 0 0 0 1 0, when either unipolar (+1,0) or bipolar (+1,-1) format is used
b) Draw the eye-diagrams, again in both unipolar and bipolar cases.

4.   A digital source generates binary words of 16 bits, at the rate of 20 000 words per second.

   a) Find the minimum bandwidth required in order to transmit the data using a binary baseband PAM signal.
   b) Determine the size M of an M-ary baseband PAM signal so that the data could be transmitted on a channel having bandwidth $B = 60$ kHz.