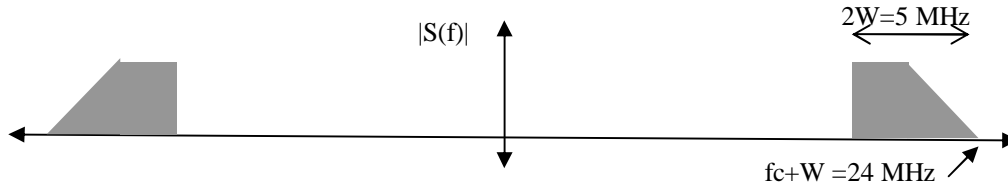
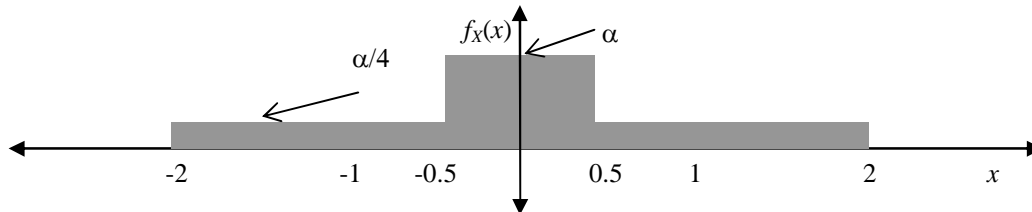


1. [5 marks] For the QCM signal with magnitude response as below,
 (a) Find the least possible band-pass sampling rate. Make a rough plot of the frequency response of the samples between f_c and $-f_c$ Hz.
 (b) If with $2W$ remaining the same, the right band-edge changes to $f_c+W = 18\text{MHz}$, what is the least sampling rate? Again, make a rough plot of the frequency response of the sampled sequence.



2. [5 marks] Given a signal $s(t) = 3\cos(200\pi t) + 4\cos^2(300\pi t)$
 (a) What is the Nyquist sampling frequency for $s(t)$?
 (b) How many uniform quantization levels are required to provide an SQNR of at least 40 dB? (*Hint*: Find the maximum value of the peak-to-peak voltage of this signal. Assume rms value is $1/\sqrt{2}$ of this max).

3. [7 marks] A signal x , described by the pdf $f_X(x)$ as below, is to be quantized:
 (a) For what value of α is this a valid pdf?
 (b) Find the quantization error variance E_q for a 2-bit uniform quantizer with left-most quantization interval $a_1=-1$, and $\Delta=1$. (*Hint*: use these to define the other quantization intervals, and the quantization levels $\{\hat{x}_1, \hat{x}_2, \dots, \hat{x}_N\}$).
 (c) Now, define the non-uniform 2-bit quantizer for this pdf, where the above uniform quantizer can be taken as the initial guess. Use the Lloyd-Max rule, and run it over 3 iterations. How does the E_q of this compare to case (b)?



4. [5 marks] For a bit-stream with 20 consecutive bits given by 10100100000010000110 specify the output sequence (using “+” for “level 1”, “-” for “level -1”, and “0” for “level 0”) for the following line-codes: (a) NRZ (b) Differential Modulation (c) AMI (d) B3ZS, and (e) B6ZS.

5. [6 marks] At an intermediate level digital multiplexer, four input streams arrive with different rates and clock ppm specified as follows: 2Mbps (10ppm), 4Mbps (5ppm), 8Mbps (2ppm), and 10Mbps (2ppm). A 16-bit frame header and a 16-bit CRC are added to every 200msec frame assembled by this multiplexer along with appropriate stuff-bits (and indicators). Make a rough sketch of the assembled frame, indicating the various important fields. What is the output bit-rate (in Mbps)?

6. [7 marks] A particular synchronous link uses N -bit long frames, with L -bit frame headers.
 (a) Describe a “parallel search” approach for framing in this case detection. How many bit-locations are searched in parallel?
 (b) On the average, how many bit intervals will elapse before framing bit is encountered?
 (c) What is probability that in n or fewer frames, there will be framing violations in the “other” $N-1$ locations? Give this expression.