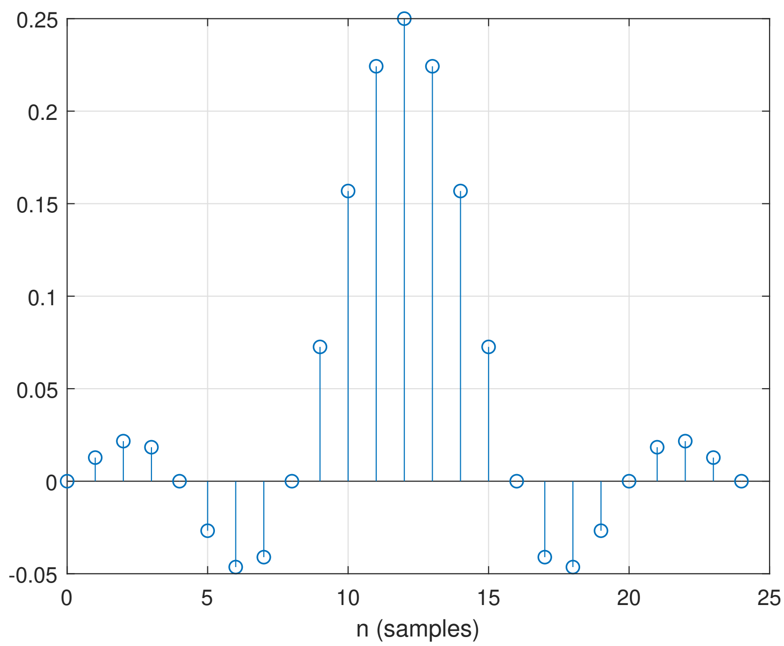
UNIVERSITY OF SASKATCHEWAN
ELECTRICAL ENGINEERING 461.3

Questions

1. Design a halfband filter using a Kaiser window, with a stopband attenuation of 60 dB and a transition width of 0.1 cycles/sample.

2. Design a halfband filter using the Parks-McClellan method, with a stopband attenuation of 60 dB and a transition width of 0.1 cycles/sample.

3. A raised cosine pulse, generated using $\beta = 0.25$ is shown below.



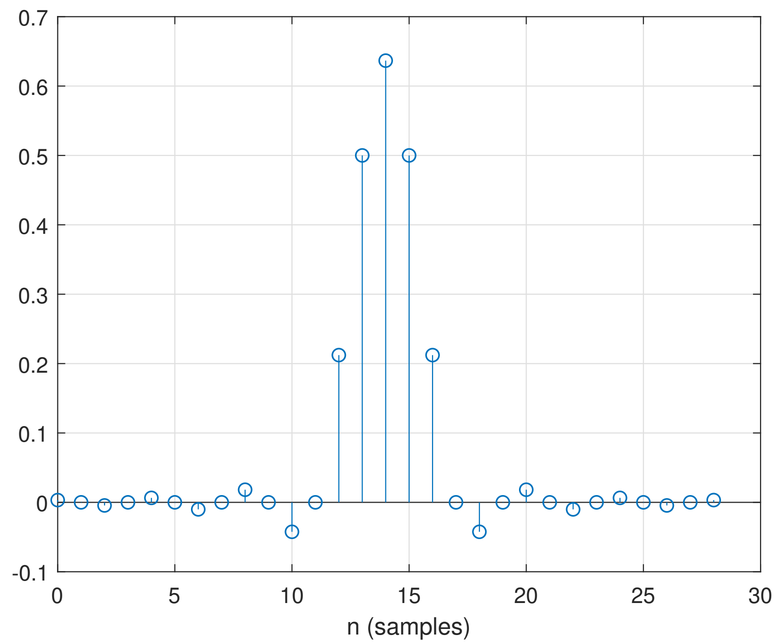
   (a) What is the number of samples per symbol?

   (b) What is the absolute bandwidth of this pulse?

   (c) What is the gain of this pulse at the cutoff frequency, f_c?

   (d) What is the nominal passband gain for this pulse?

4. A square root raised cosine pulse with a span of 7 symbols is given in the following figure. This pulse was generated to have maximum bandwidth, using the MATLAB function, rcosdesign.



(a) What is the value of β?

(b) What is the number of samples per symbol?

(c) What is the value of the cutoff frequency, f_c?

(d) What is the gain of this pulse at the cutoff frequency, f_c?

(e) If this pulse is convolved with itself, what is the peak value of the result?

5. Given the filter specifications, $\beta = 0.2$, $N_{sps} = 4$, $N_{symb} = span = 25$ and the nominal passband gain is 0 dB, complete the following questions.

   (a) Generate the impulse response of a square root raised cosine pulse shaping filter.

   (b) Generate, using `firpm`, the impulse response of a square root Nyquist pulse shaping filter.

   (c) Plot the two impulse responses on a single figure.

   (d) Plot the dB magnitude response of the two filters on a single figure.

   (e) If β is decreased to 0.1, what is the effect on the stopband attenuation of the two filters. If there is a change in the stopband attenuation, provide an explanation of why?

6. Given the specifications, $\beta = 0.2$, $N_{sps} = 4$, $N_{symb} = span = 25$ and the impulse response has unit energy, complete the following questions.

   (a) Generate the impulse response of a square root raised cosine pulse shaping filter.

   (b) Generate, using `firpm`, the impulse response of a square root Nyquist pulse shaping filter.

   (c) Plot the two impulse responses on a single figure.

   (d) Plot the dB magnitude response of the two filters on a single figure.

   (e) Is the stopband attenuation for the filters the same as the previous question?

7. Consider a pulse shaping filter followed by a matched filter, both having a unit energy square root raised cosine impulse response with the following specifications, $\beta = 0.2$, $N_{sps} = 4$, $N_{symb} = span = 25$.

   (a) Generate a thousand sample random sequence consisting of two amplitudes: 1 and -1. Insert $N_{sps} - 1$ zeros between each sample and use this as the input to the pulse shaping filter. Generate (using `conv`) and plot the output of the pulse shaping filter.

   (b) Generate and plot the output of the matched filter.

   (c) Determine the output sequence by sampling the matched filter output every N_{sps} samples, taking into consideration the transients at the beginning and end. Plot this sequence.

   (d) Given the input sequence and the output sequence, calculate the ISI and plot it.

   (e) Calculate the RMS ISI value.

   (f) Generate a linear magnitude response plot of the convolution of the square root raised cosine pulse with itself. What is the pulse generated by the convolution called? Is the transition band spectrum generated from the convolution odd symmetric about the cutoff frequency?

   (g) Generate the dB magnitude response plot of the square root raised cosine pulse. What is the stopband attenuation.

8. Repeat the previous question using a square root Nyquist impulse response generated using `firpm`. For the odd symmetric question of 7f), note that for the current question the spectral bump near f_p is in the transition band. Compare the RMS ISI and the stopband attenuation with the previous question.

9. The spectral bump that can be observed near the passband corner frequency in the plot of question 8f) affects both the ISI and stopband attenuation. This spectral bump can be reduced using an approach from the Harris paper listed in the slides that involves increasing f_p in small increments for the square root Nyquist impulse response until the ISI stops decreasing. Repeat question 8 implementing this approach from the Harris paper. Compare the RMS ISI and the stopband attenuation with the previous two questions.

10. Another approach to reducing the spectral bump in the plots of question 8f) is to increase the weighting of the passband in the `firmpm` argument `wght`. Repeat question 8 increasing the passband weighting from 2.4535 to 10. Compare the RMS ISI and the stopband attenuation with the previous three questions.