

1. Design a length-16 FIR low pass filter with cutoff frequency  $\omega_c = \frac{\pi}{3}$  radians, using the window design method.
  - (a) Find an expression for the coefficients  $\{h[n]\}_{n=0}^{n=15}$  using truncation (rectangular) window.
  - (b) Find an expression for the coefficients  $\{h[n]\}_{n=0}^{n=15}$  using Hamming window.
2. Find an expression for the coefficients  $\{h[n]\}_{n=0}^{n=31}$  (length-32) FIR high-pass filter with cutoff frequency  $\omega_c = \frac{2\pi}{3}$  radians, using the following methods
  - (a) Directly using window design and using truncation (rectangular) and Hamming windows
  - (b) First designing a low-pass filter and converting it to a high-pass filter.
3. The ramp filter, with ideal frequency response  $D(\omega) = |\omega|$  for  $|\omega| \leq \pi$ , is useful for correcting certain types of distortion.
  - (a) Find the impulse response,  $d[n]$ , of the ideal ramp filter.
  - (b) The ideal impulse response is non-causal and infinite in length, which is not very useful in practice. Use a Hamming window to approximate the ramp filter by a length 7 causal FIR filter  $h[n]$ . Give the coefficients of  $h[n]$ .
  - (c) Does your filter have generalized linear phase? If so, what type?
4. Use the frequency sampling method to design a length-100 FIR high-pass filter having cutoff frequency  $3\pi/4$ .
  - (a) Determine the type of the filter?
  - (b) Find an expression for the filter coefficients  $\{h_n\}_{n=0}^{99}$ .
5. A length-18 generalized linear phase low-pass filter is designed using the Parks-McLellan method, to approximate an ideal lowpass-filter with cutoff  $0.3\pi$ , and transition band of width  $0.2\pi$ . The error-weights in the passband and stopband are 8 and 18, respectively. Sketch by hand a possible magnitude-frequency response of the resulting filter, and explain what considerations you used to produce your sketch.

6. Figures below show the magnitude of the frequency response of an FIR filter designed using truncation and Hamming windows. Identify which method was used for each of the filter types below. Explain your answer.

