Exercise 6

Remez Algorithm

1. Design a linear-phase FIR filter, whose frequency response $H(e^{j\omega})$ has the following specifications:

$$|H(e^{j\omega})| = 0, \text{ for } \omega \in [0, 0.2\pi] \text{ with ripples } 0.01$$
$$|H(e^{j\omega})| = 1, \text{ for } \omega \in [0.3\pi, 0.4\pi] \text{ with ripples } 0.1$$
$$|H(e^{j\omega})| = 0, \text{ for } \omega \in [0.5\pi, 0.6\pi] \text{ with ripples } 0.01$$
$$|H(e^{j\omega})| = 1, \text{ for } \omega \in [0.7\pi, \pi] \text{ with ripples } 0.1$$

   Plot the impulse response of the filter. Is it linear-phase? If yes, what is the type of the filter. Verify that the filter meets the specifications. (Hint: `help firpmord`).

2. Design a linear phase FIR filter, whose frequency response $H(e^{j\omega})$ has the following specifications:

$$|H(e^{j\omega})| = 0, \text{ for } \omega \in [0, 0.2\pi] \text{ with ripples } 0.001$$
$$|H(e^{j\omega})| = 1, \text{ for } \omega \in [0.25\pi, 0.6\pi] \text{ with ripples } 0.01$$
$$|H(e^{j\omega})| = 0, \text{ for } \omega \in [0.7\pi, \pi] \text{ with ripples } 0.01$$

   Plot the linear scale frequency response of the filter. What is your observation? Try to find a way to get rid of this problem. Please note that your solution should not alter any of the given filter parameters.

3. It is desired to design a type II linear-phase FIR filter using Remez algorithm, which meets the following specifications:

$$|H(e^{j\omega})| = 1, \text{ for } \omega \in [0, 0.04\pi] \text{ with ripples } 0.01$$
$$|H(e^{j\omega})| = 0, \text{ for } \omega \in [0.08\pi, \pi] \text{ with ripples } 0.001$$

   Express the weighted error function for the above specifications (Hint: Lecture notes, Part III, Page 194). Check your weights using the MATLAB function `firpmord`.

4. Consider a linear-phase FIR filter of order 4, whose frequency response $H(e^{j\omega})$ should have the following specifications:

$$|H(e^{j\omega})| = 1, \text{ for } \omega \in [0, 0.2\pi] \text{ with ripples } 0.3$$
$$|H(e^{j\omega})| = 0, \text{ for } \omega \in [0.8\pi, \pi] \text{ with ripples } 0.2$$

   Perform one round of Remez algorithm for this filter (Hint: Lecture notes, Part III, Page 205).