Problem 1

Design a low pass FIR filter with parameters: passband Fpass=4 MHz; stopband Fstop=5MHz; attenuation at least 50dB in the stopband (out-of-band attenuation). Let the sampling frequency be Fs=30MHz. Determine the design with the lowest computational complexity.
Provide code.

Problem 2

Using at least 3 different windows, implement frequency domain approximations of an ideal bandpass filter to pass a signal within frequencies 4MHz and 5MHz with the attenuation outside (<3.8MHz and >5.2MHz) ≥60dB, and the ripple<=0.3dB within the passband. Find a minimal size of each window (min filter order). Sampling frequency is Fs=20MHz.
Provide code.

Problem 3

Approximate a filter with the frequency response

$$H(f) = \begin{cases} exp(-|f|/10^6) & |f| < 1MHz \\ 0 & |f| > 1.1MHz \end{cases}$$

Let the sampling frequency be Fs = 5 MHz, and the attenuation in the stopband be 50dB. Determine the impulse response of a FIR filter, which approximates this frequency response. Plot the frequency response in terms of magnitude and phase to verify that the approximation holds. Provide code.

Problem 4

Design a low pass filter with passband Fpass=5 MHz, stopband Fstop=5.5MHz, attenuation of at least 50dB, sampling frequency Fs=20MHz. Design at least 3 versions of **multiplier-free** FIR filters with the least order. You can combine low-order filters to solve the problem.
Plot impulse and frequency responses. Compare with a common FIR filter. Provide code.

Problem 5

In the DAC we want to use the linear interpolation between samples instead of the Sample and Hold, as shown in the figure below. This is a First Order Hold reconstruction given by the $x(t) = \sum_{n=-\infty}^{+\infty} x[n]g(t - nT_s)$, where $g(t)$ is the triangle pulse
a) Calculate (in math and by simulations) frequency response of DAC output, considering that $x(t)$ is the band-limited white noise with bandwidth 5 times lower than F_s
b) Show the difference between Sample and Hold and First Order Hold.
Plot impulse and frequency responses. Provide code.