7.1 A simple alternative to the difference of Gaussians filter for image enhancement is the difference of boxes with impulse response: 
\[ h(x) = A b_1(x) - B b_2(x) \]
where 
\[ b_i(x) = u(x + \frac{w_i}{2}) - u(x - \frac{w_i}{2}) \].
Let \( A = 3, B = 1 \), \( W_1 = 1 \), and \( W_2 = 3 \) for parts a and b.

a. Find and sketch the frequency response, \( H(u) \).
b. Find and sketch the unit step response, \( g(x) \).
c. What values of the parameters \( A, B, W_1 \), and \( W_2 \) would you use to match this filter to the frequency response of the human visual system? Explain your assumptions and approximations clearly. Discuss any differences between this filter and the difference of Gaussians to a human observer.

7.2 [Advanced] Consider a difference of exponential low pass filters model of the human visual system:
\[ H(u) = H_1(u) - H_2(u), \]
with:
\[ H_1(u) = \frac{10}{1 + (2\pi u/b)^2} \quad \quad \quad H_2(u) = \frac{9}{1 + (2\pi u/a)^2} \]
Assume that \( b = 3a \).
a. Find and sketch the impulse response, labelling the zero crossings.
b. Show that the model’s frequency response can be expressed as the product of a low pass filter (which might represent the physiological optics) and a deblurring filter (which might represent a neural lateral inhibition mechanism in the retina).
c. Use the deblurring filter you found in part b to find the blur process the neural mechanism is correcting for. Give its impulse response in terms of \( a \).
d. While it is algebraically involved to find the exact frequency of maximum response, you might approximate it using the frequency where \( H_2(u) \) drops to 10% of its DC value. What value of \( a \) puts this point at 8 cycles per degree? What is the approximate cut-off frequency of the model for this \( a \)? (Bonus: Where is the frequency of maximum response?)

7.3 Suppose you want an edge detector that is less noise sensitive than the Laplacian operator. You decide to apply an exponential low pass filter before applying the Laplacian, achieving a frequency response for your edge detector given by:
\[ H(u) = (2\pi u)^2 \left( \frac{1}{1 + (2\pi u/a)^2} \right). \]
a. Find and sketch the impulse and unit step response of this filter.
b. How does the filter compare to the Laplacian of a Gaussian filter in terms of noise sensitivity and edge response?
c. Suppose you decide to enhance the noise smoothing characteristic of your scheme by applying the exponential low pass filter twice before taking the Laplacian. Describe your resulting filter's performance as an edge detector.