Problem 3.1
Consider an RC-lowpass filter of first order, described by the frequency response

\[ H(f) = \frac{1}{1 + j2\pi fRC}. \]

The rectangular pulse

\[ x_T(t) = \begin{cases} 
1 & \text{for } |t| \leq T/2 \\
0 & \text{for } |t| > T/2 
\end{cases} \]

is applied to the input of this linear system.

(a) Find the output signal \( y(t) \) of the RC-lowpass by solving the convolution integral.

(b) Illustrate the signals involved in this convolution integral and emphasize the integration intervals that need to be distinguished in its evaluation.

Problem 3.2
Find the Fourier transform of a switched sine-pulse, given as

\[ x(t) = \begin{cases} 
A \sin(2\pi f_0 t) & \text{for } |t| \leq T/2 \\
0 & \text{for } |t| > T/2 
\end{cases} \]

Use the tables of Fourier transform properties and Fourier transform pairs!

Problem 3.3
Find the Fourier transform of a triangular pulse, given as

\[ x(t) = \begin{cases} 
1 - |t| & \text{for } |t| \leq 1 \\
0 & \text{for } |t| > 1 
\end{cases} \]

Use the tables of Fourier transform properties and Fourier transform pairs!

Problem 3.4
Compute the Fourier transform of the rectangular pulse \( x_T(t) \) of Problem 3.1.