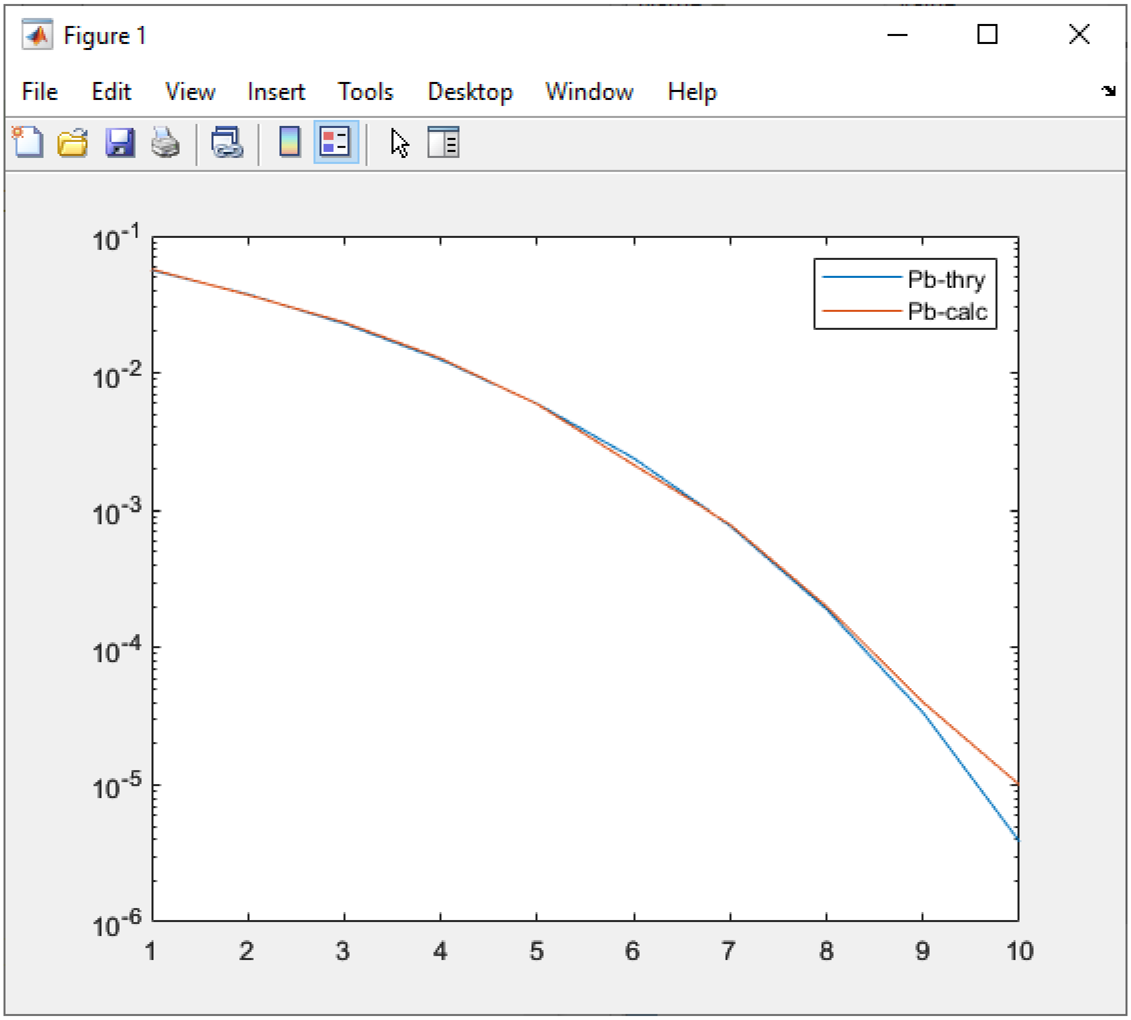
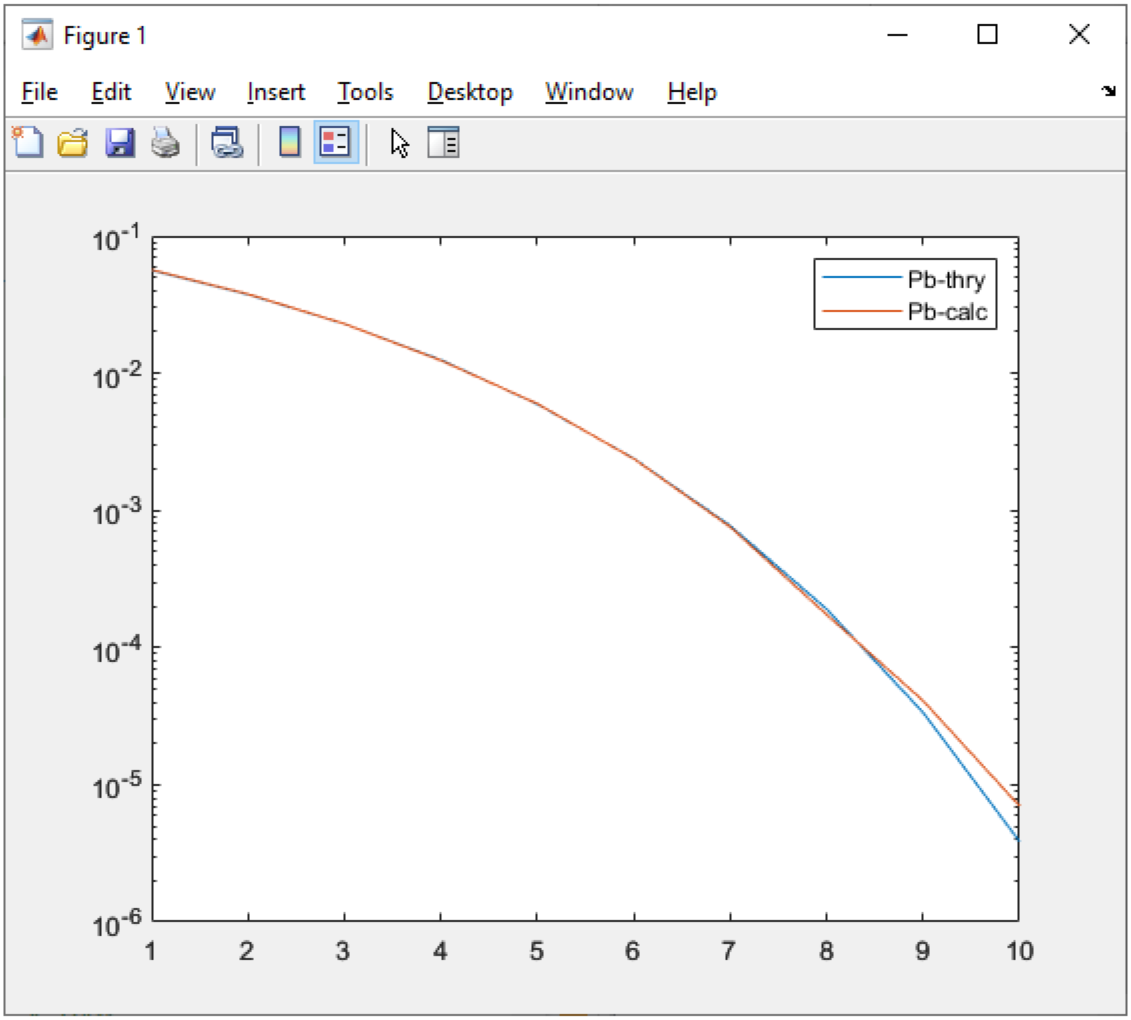
Lab 3

Part 1

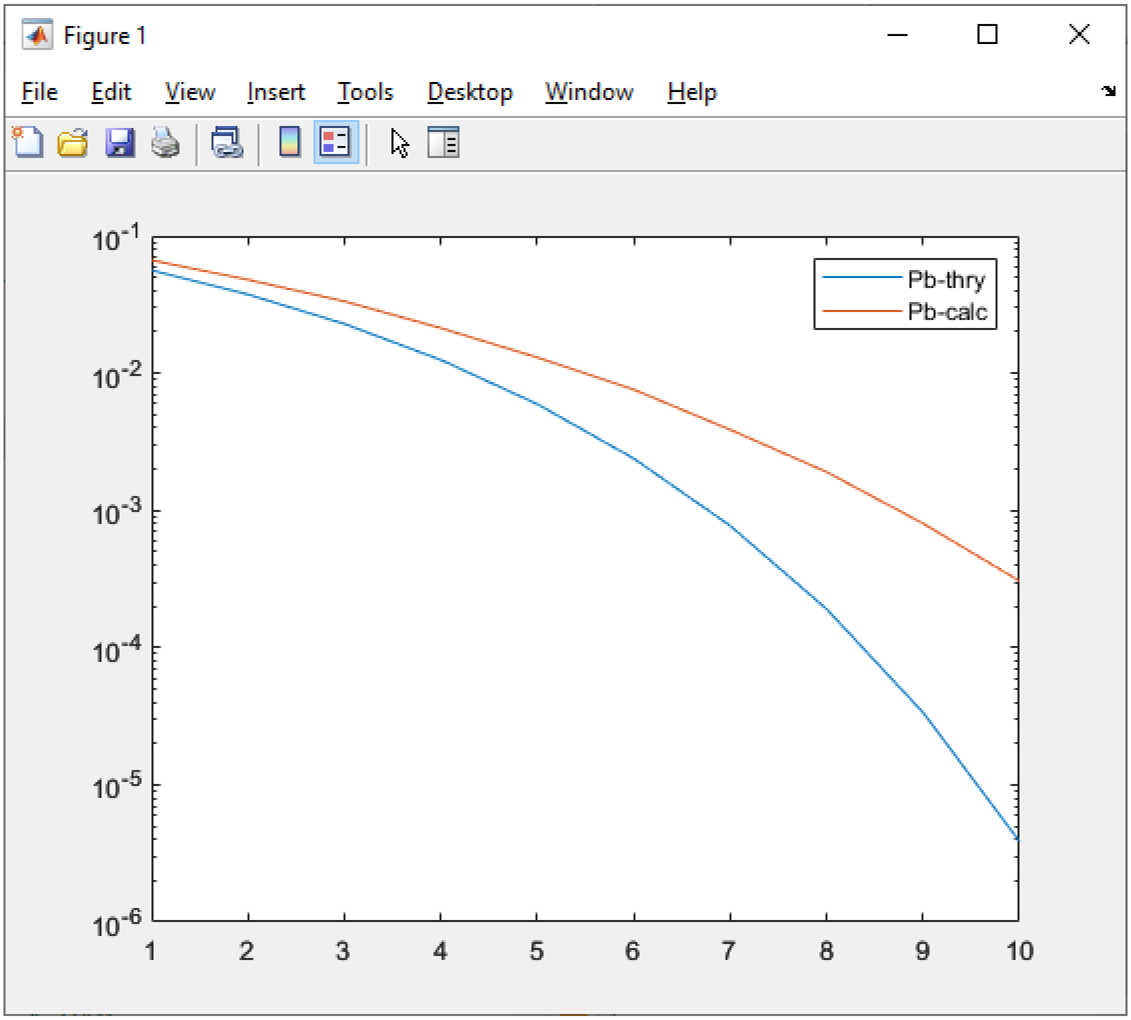
Step 2: Replace the rectangular pulse with a root raised cosine pulse, with a roll-off factor of $\beta=0.5$ and a truncated pulse duration of $L=128$ symbol periods.



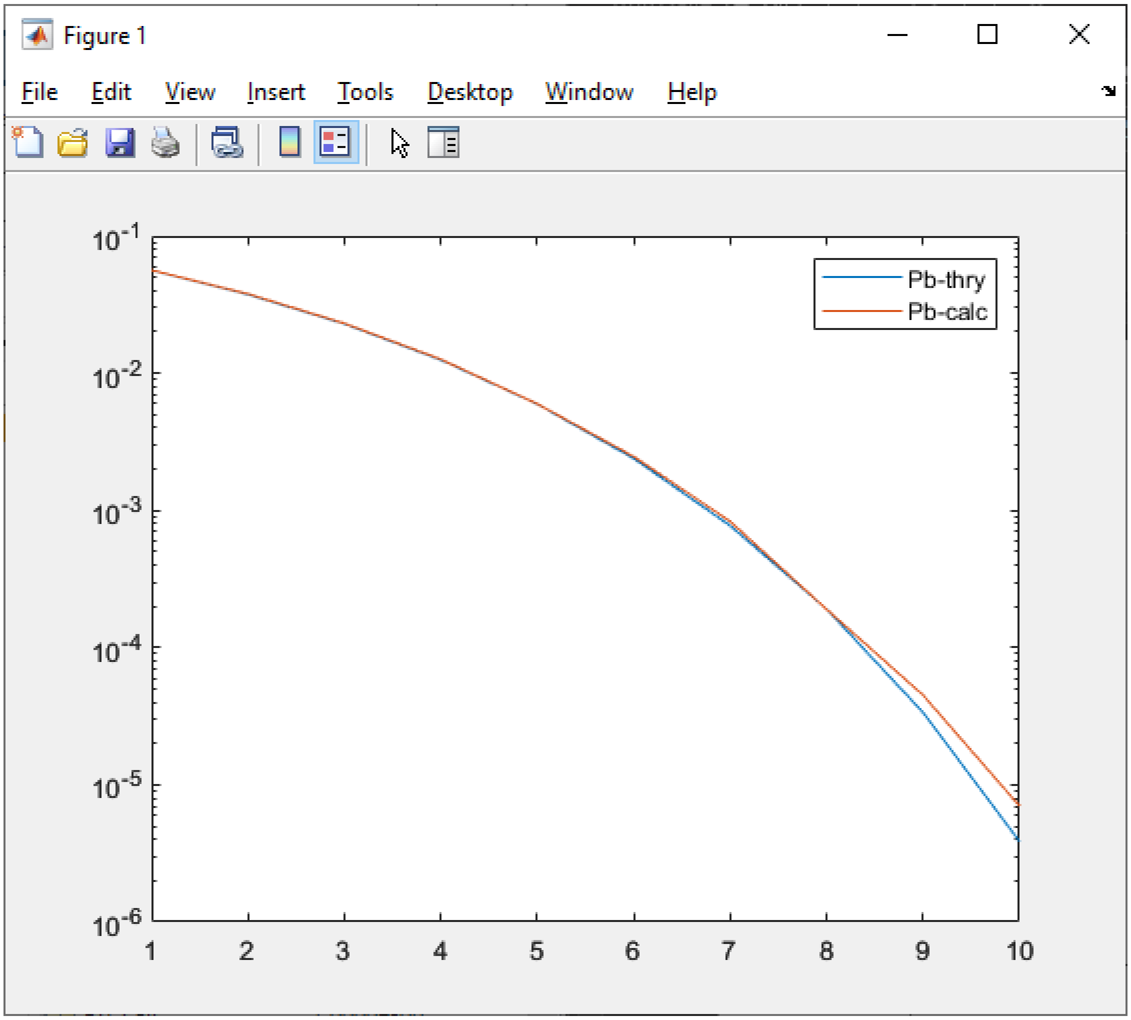
Step 3: Test the simulator in the presence of noise. Increase the message word length to $N_a=1000$ bits and simulate $N_f=1000$ message words. Use $\beta=0.5$, but reduce L to 4. For $E_b N_0/$ in the range of 0 dB to 10 dB with a step size of 1 dB, plot the BER vs. $E_b N_0/$ in a graph, along with the theoretical BER for when the channel is not band-limited. The theoretical and experimental bit error rates should be very similar.



Next, rerun your simulation with β=0.1 and L=4. There should now be a big difference between the theoretical and experimental results.



Rerun your simulation with $\beta=0.1$ and $L=16$. The theoretical and experimental results should now match closely.



Step 4: Using the techniques you learned in Lab #1, calculate and plot the power spectral density of the transmitted bandpass signal, $v_c(t)$. Use the following parameters: N_a=1000 bits, T=0.01 seconds, η=64 samples per symbol, and a carrier frequency of f_c=800 Hz. Use a root raised cosine filter with parameters β=0.5 and L=4. Use N_f=1000 frames to get smooth results.

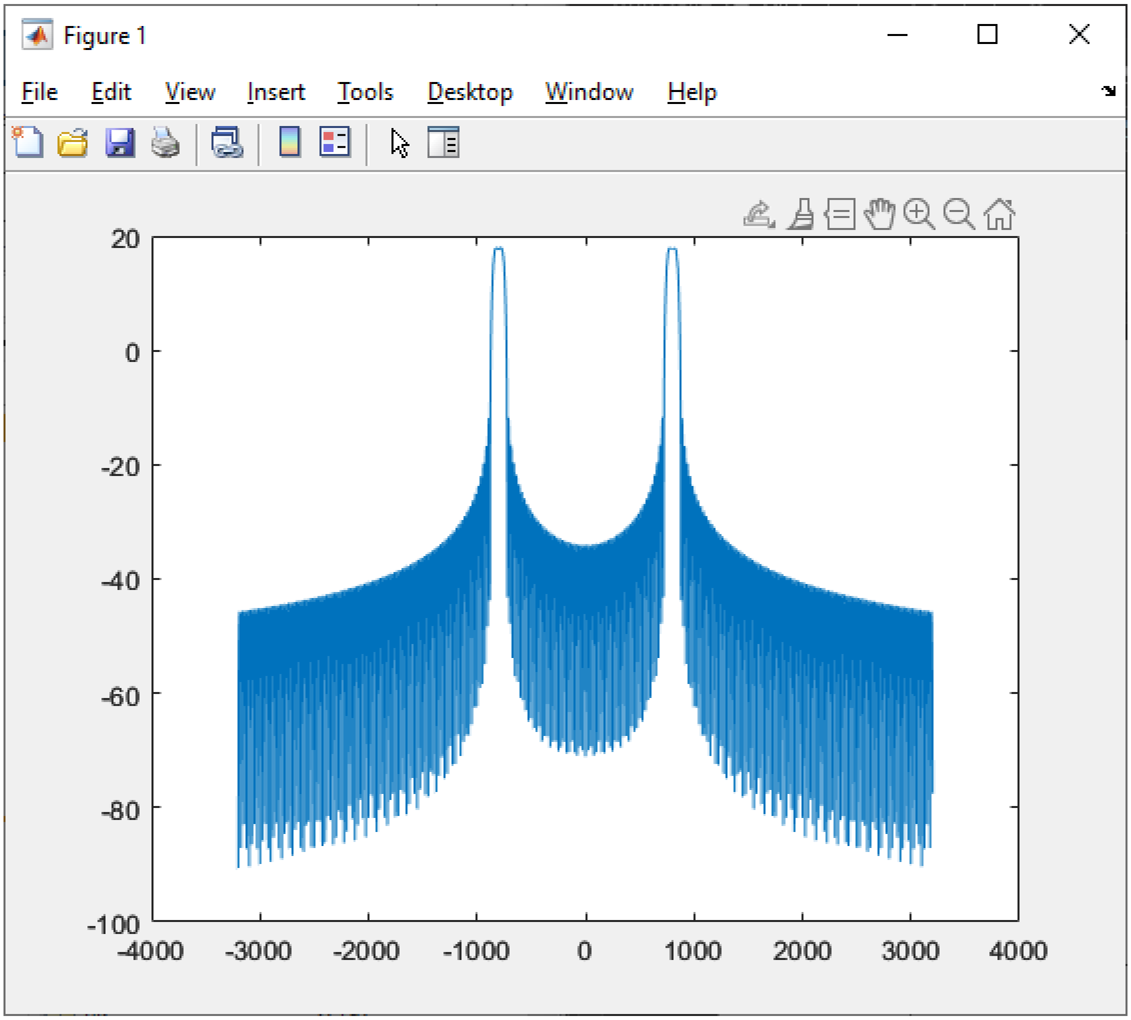


Figure 1
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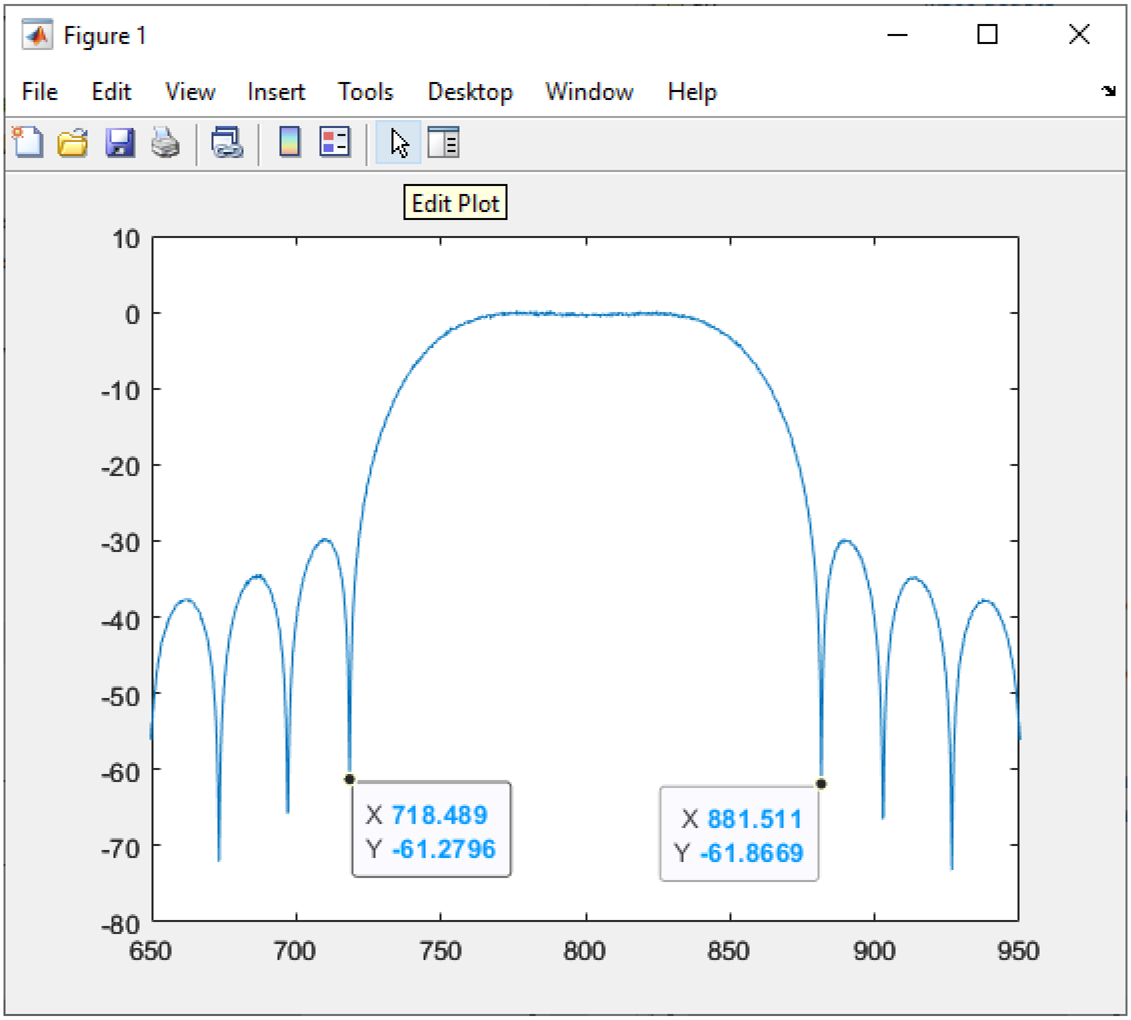
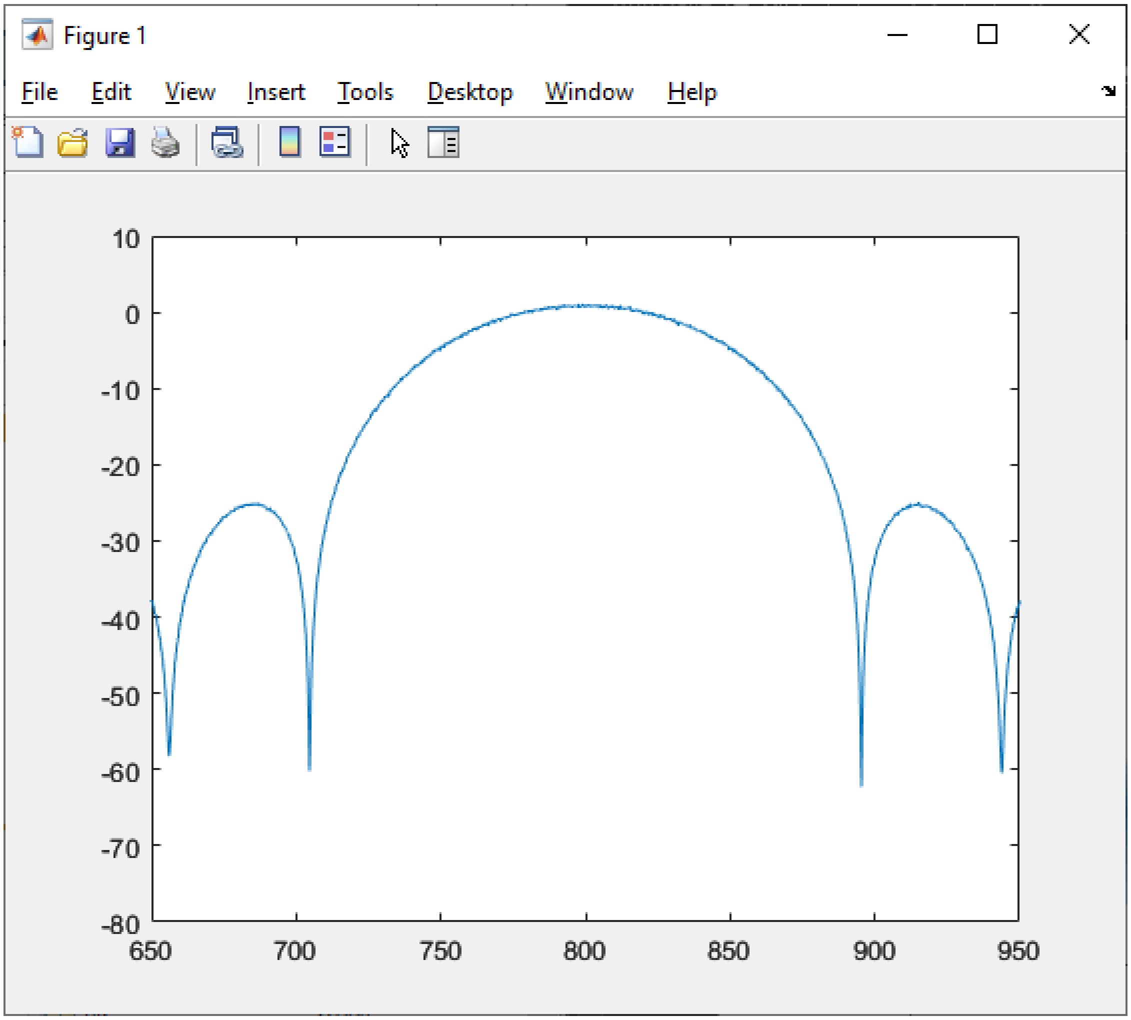


(1+beta)/T = 1.5/0.001 = 150

881.511 – 718.489 = 163.022

Try changing the parameters a bit to see their effects on the PSD. For $\beta=0.5$, try different values of L (e.g., with $L \in \{2,4,8,32\}$, if possible plotting them all in the same graph). Observe that the sidelobes decrease with larger L, and the null-to-null bandwidth comes closer to $(1+\beta)/T$.



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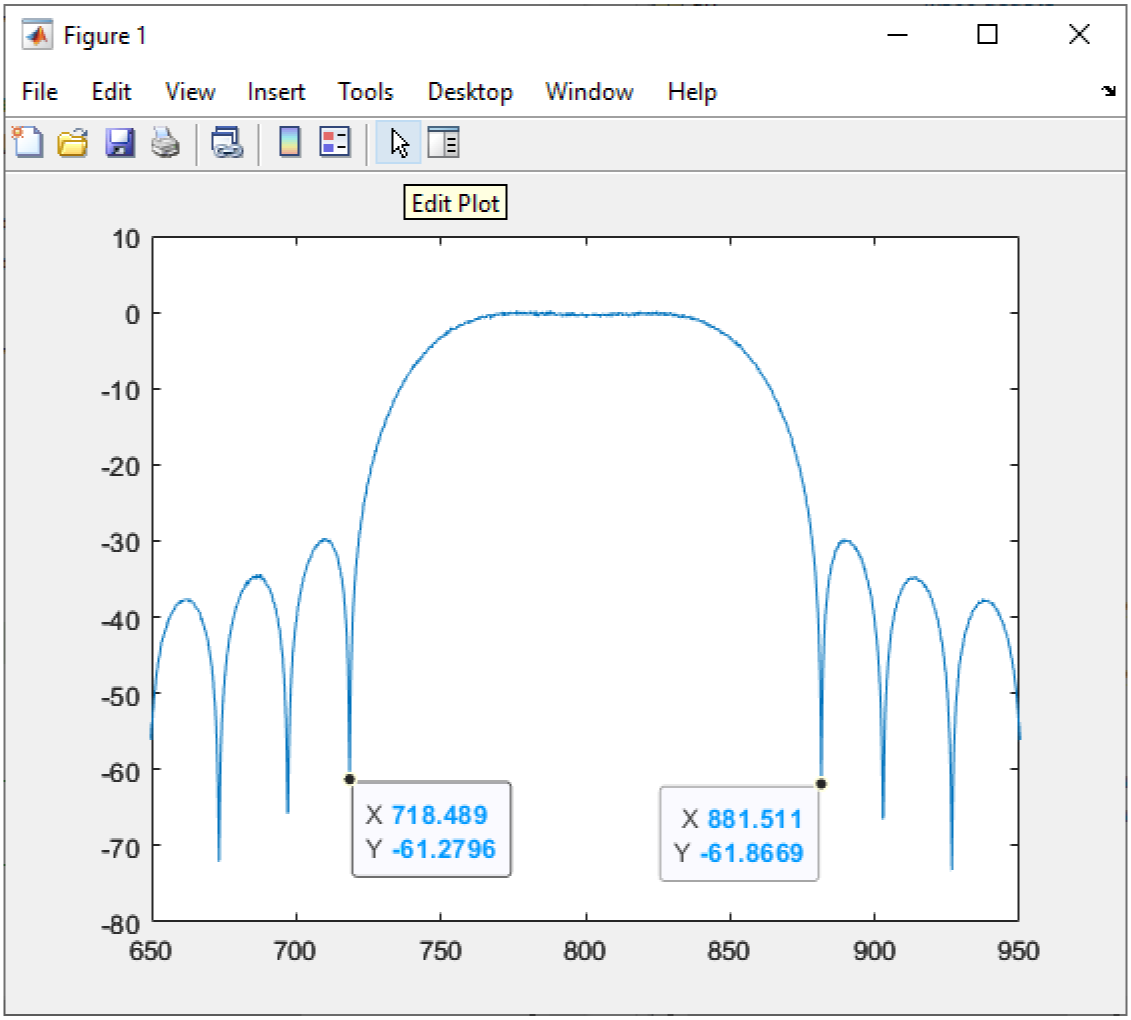
L = 2



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X 718.489
Y -61.2796
X 881.511
Y -61.8669

L = 4

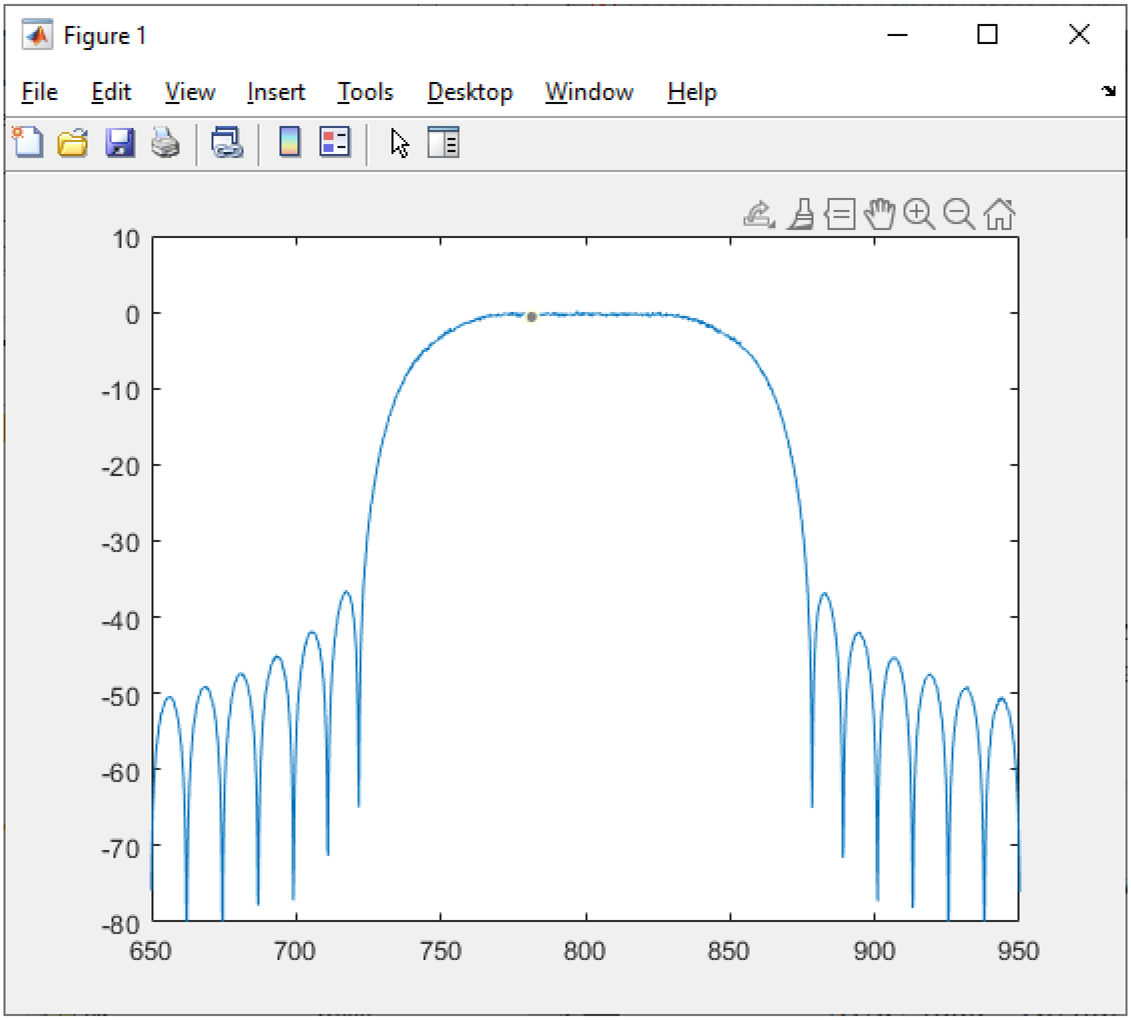

Figure 1
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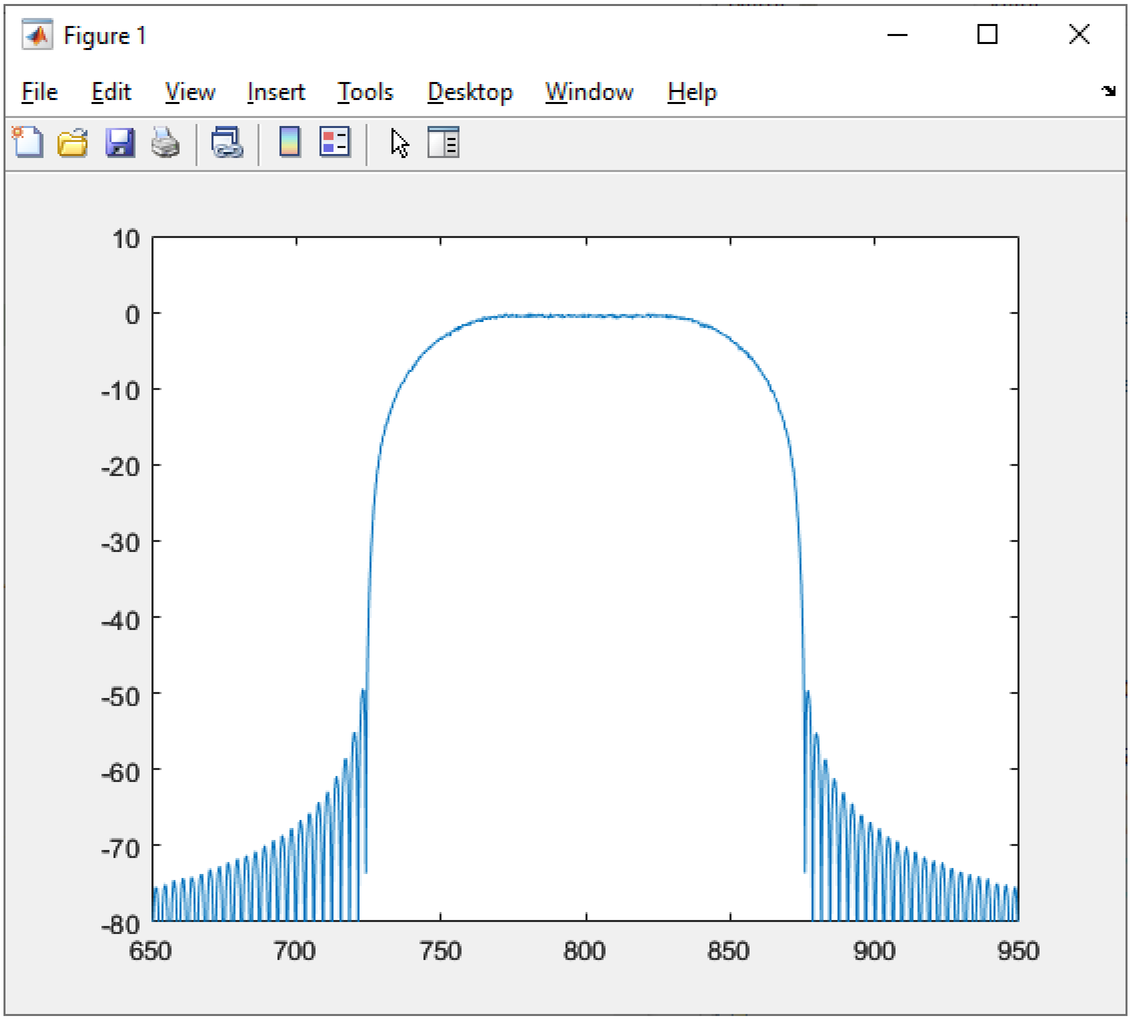
L = 6



L = 32

For L=16, try different values of β (e.g., with $\beta\in\{0,0.2,0.5,0.8,1\}$). Observe that the null-to-null bandwidth changes with β, and the sidelobes decrease with larger β.

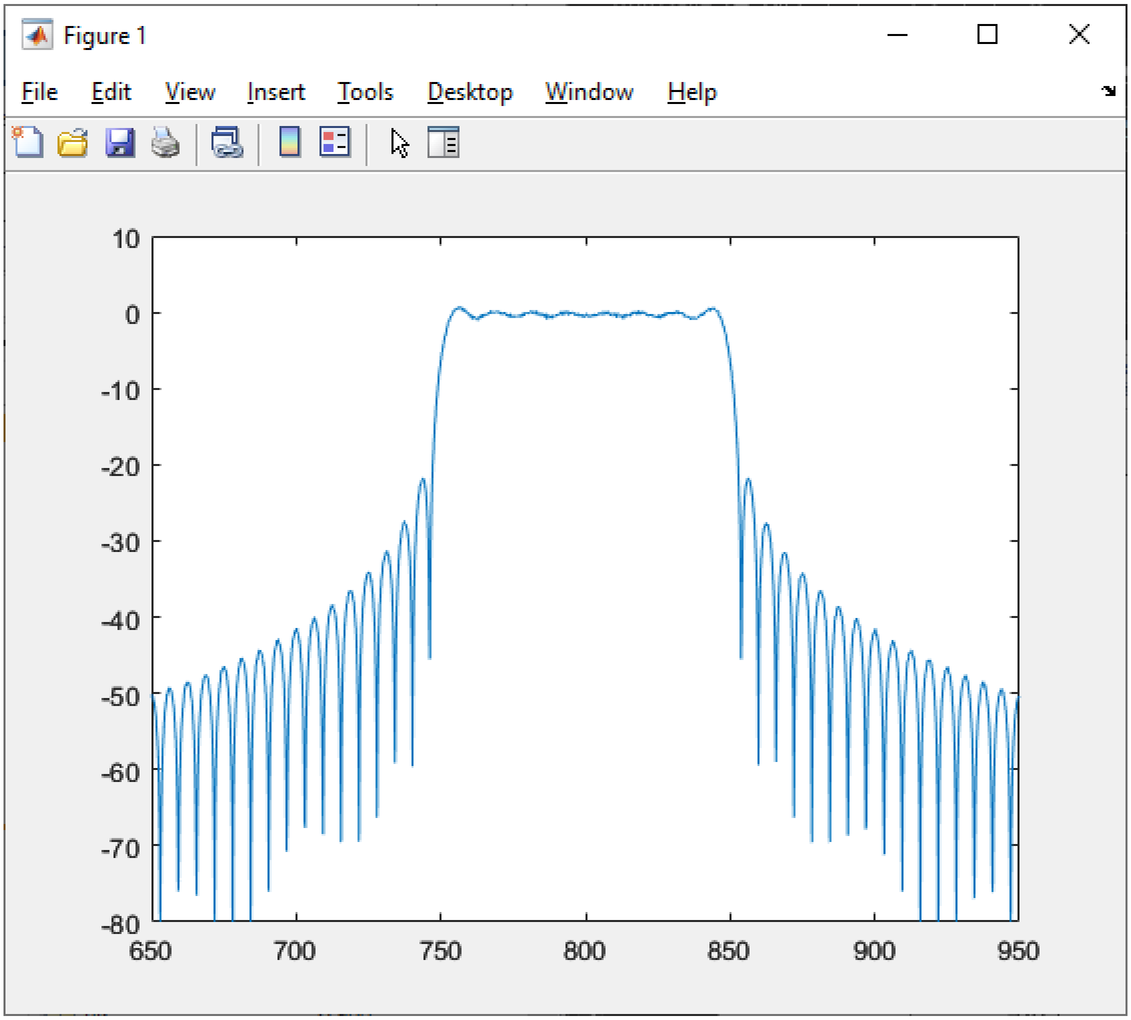


Figure 1
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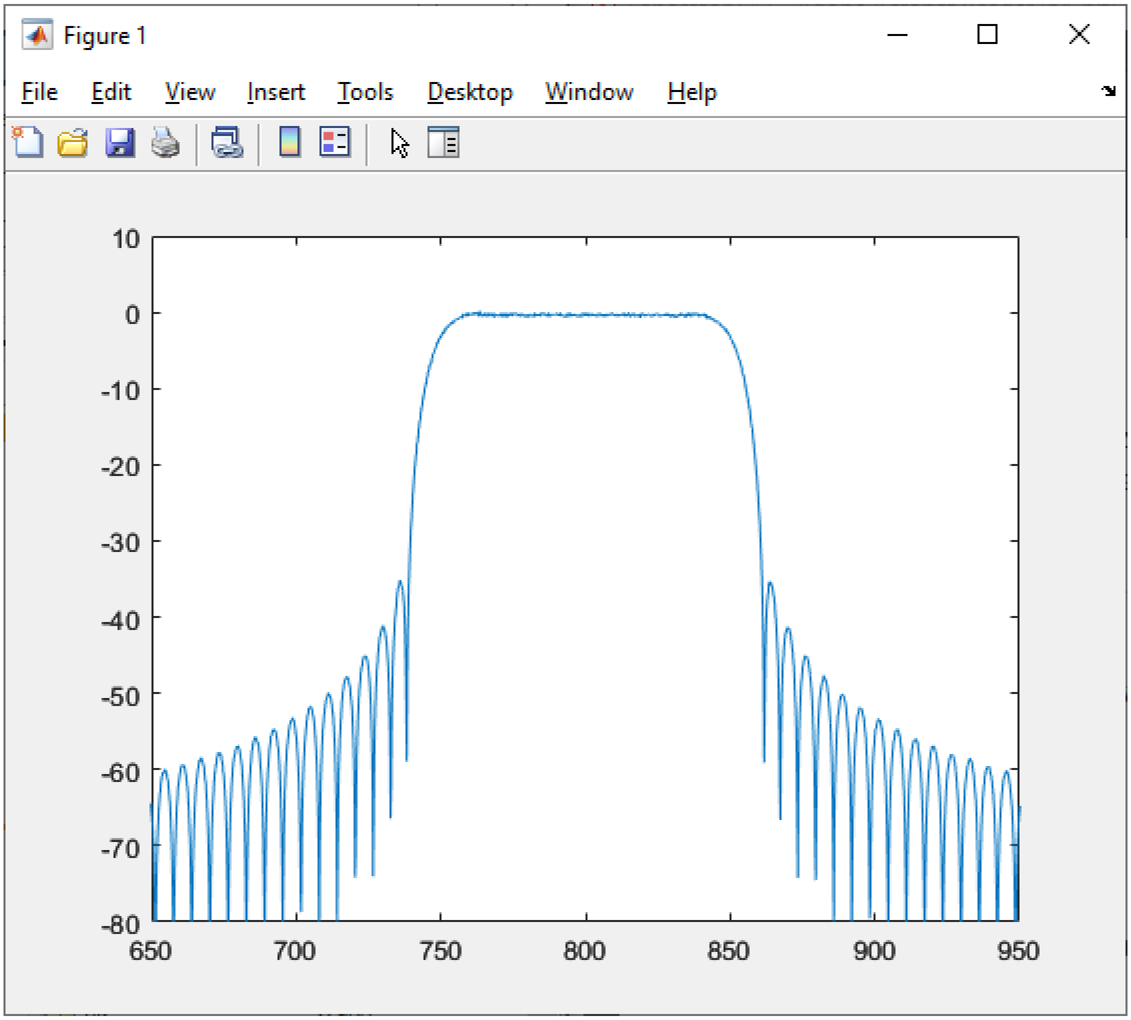
Beta = 0



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Beta = 0.2

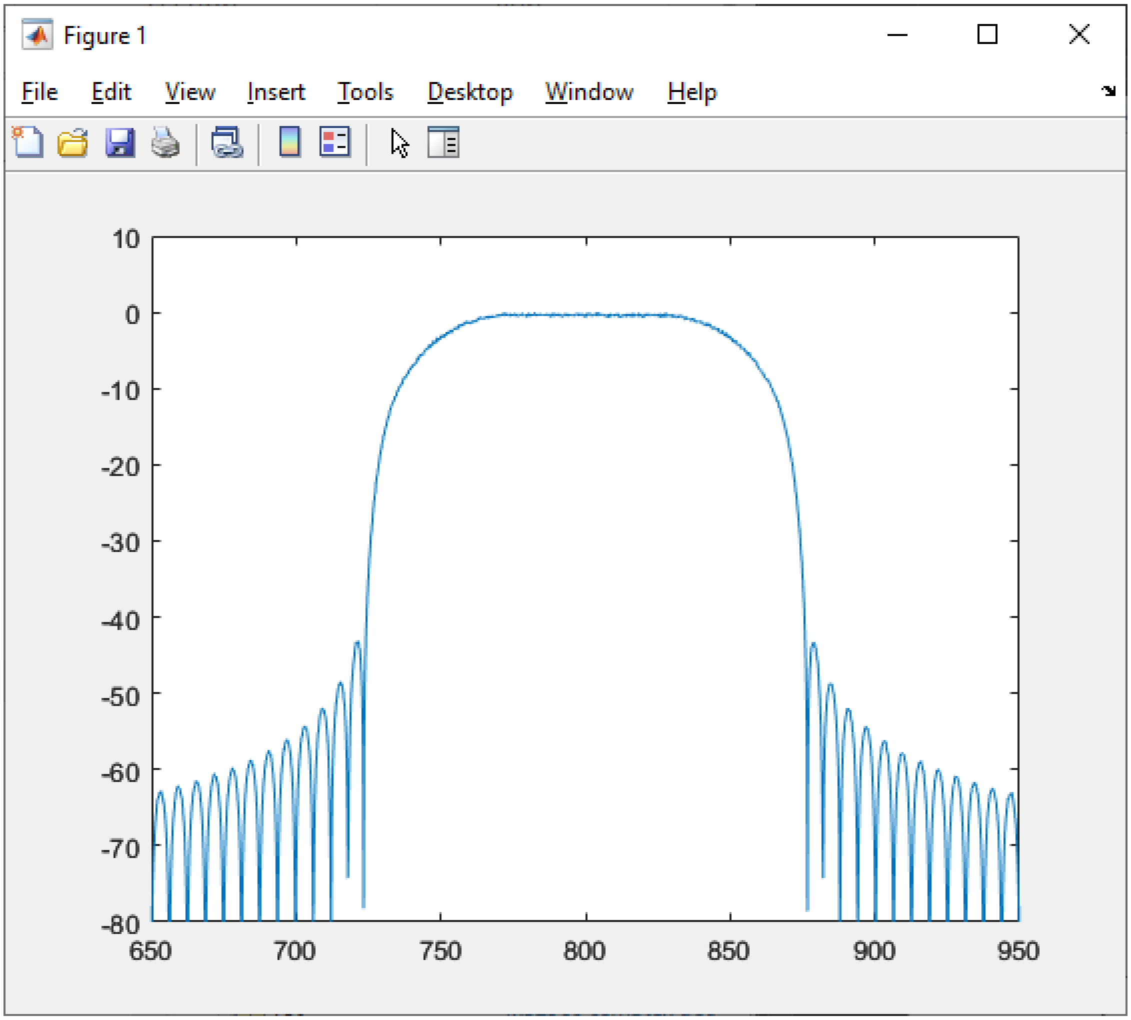

Figure 1
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Beta = 0.5

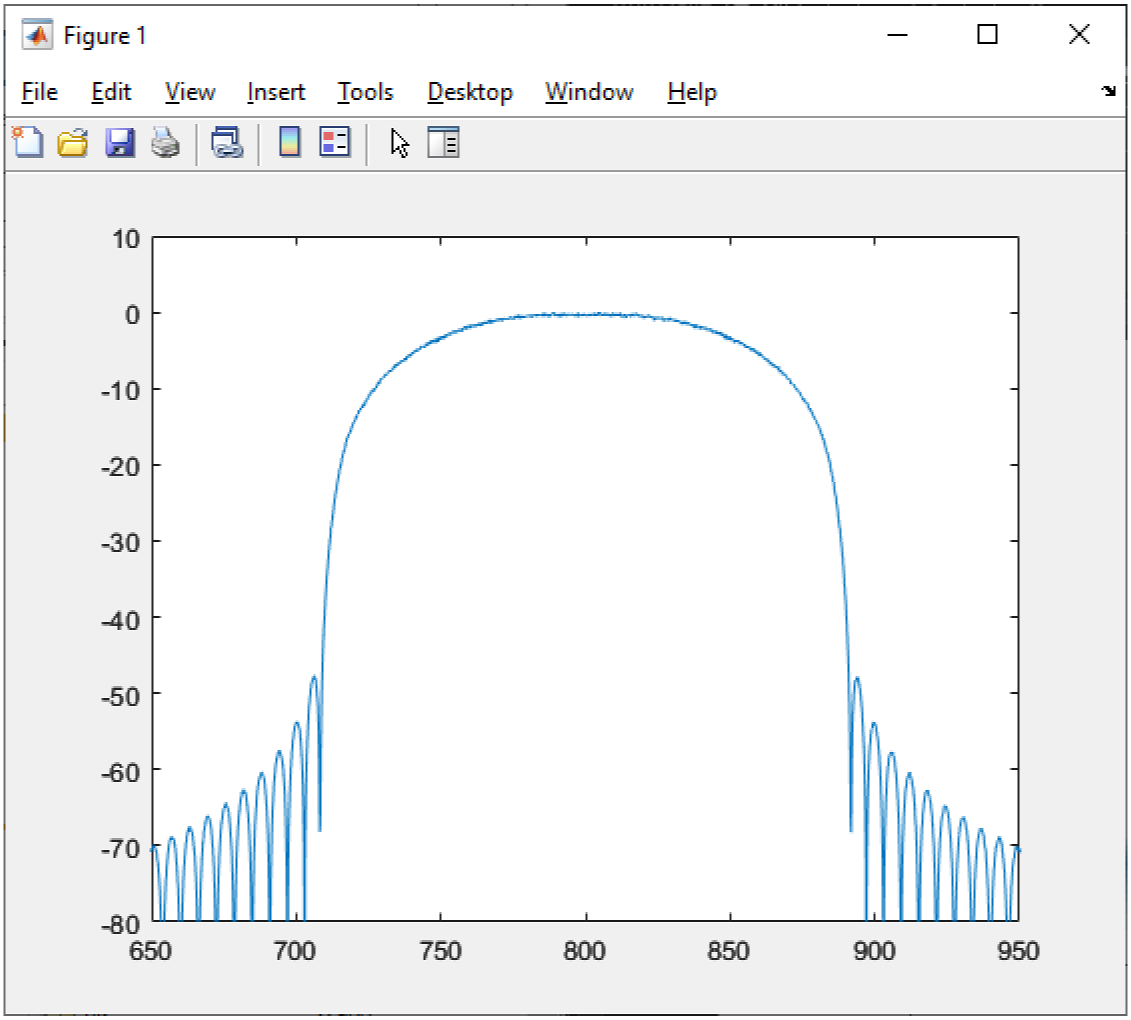
Figure 1
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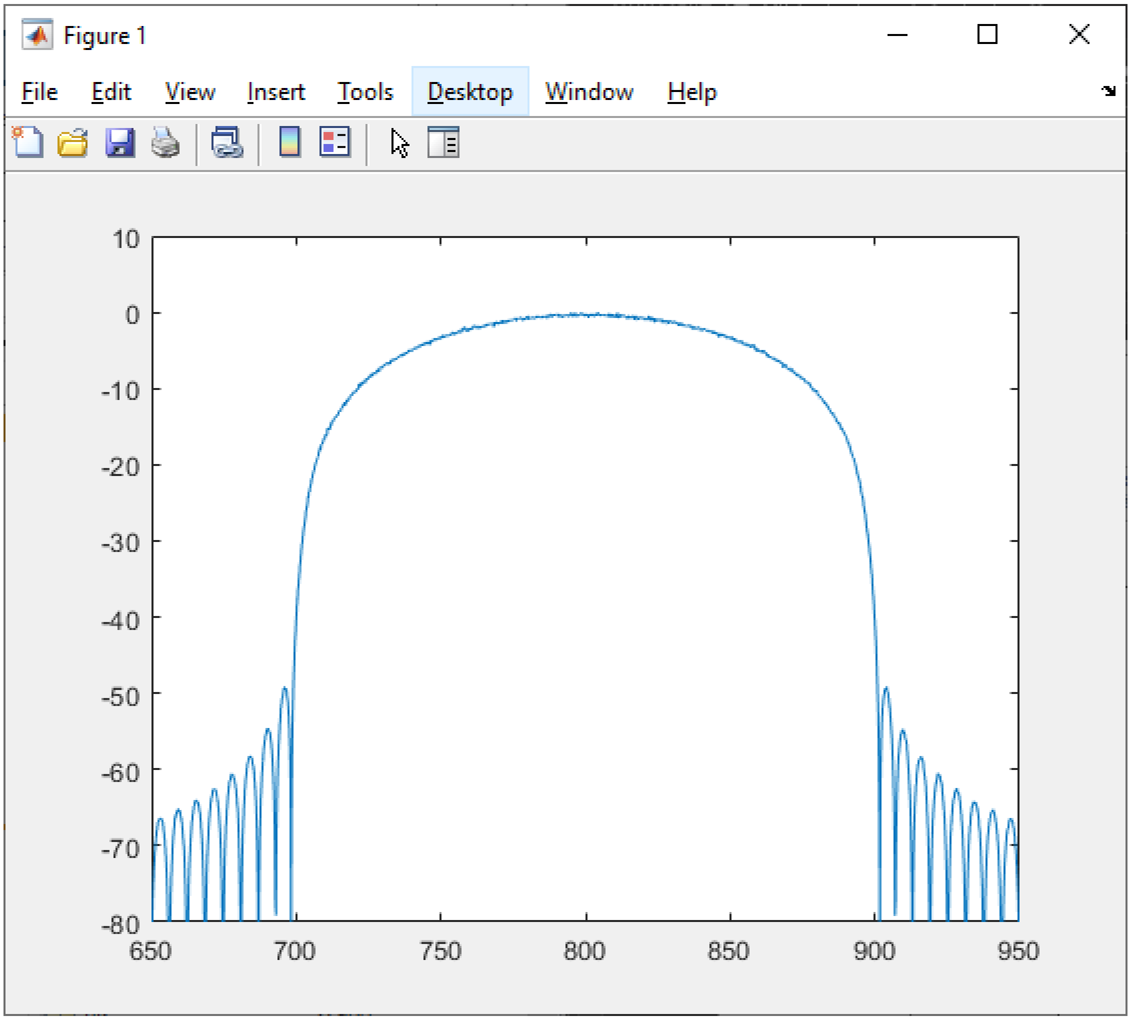
Beta = 0.8



Beta = 1

For L=4 and β=0.5, try different values of T (with $T \in \{0.02, 0.01, 0.007\}$).

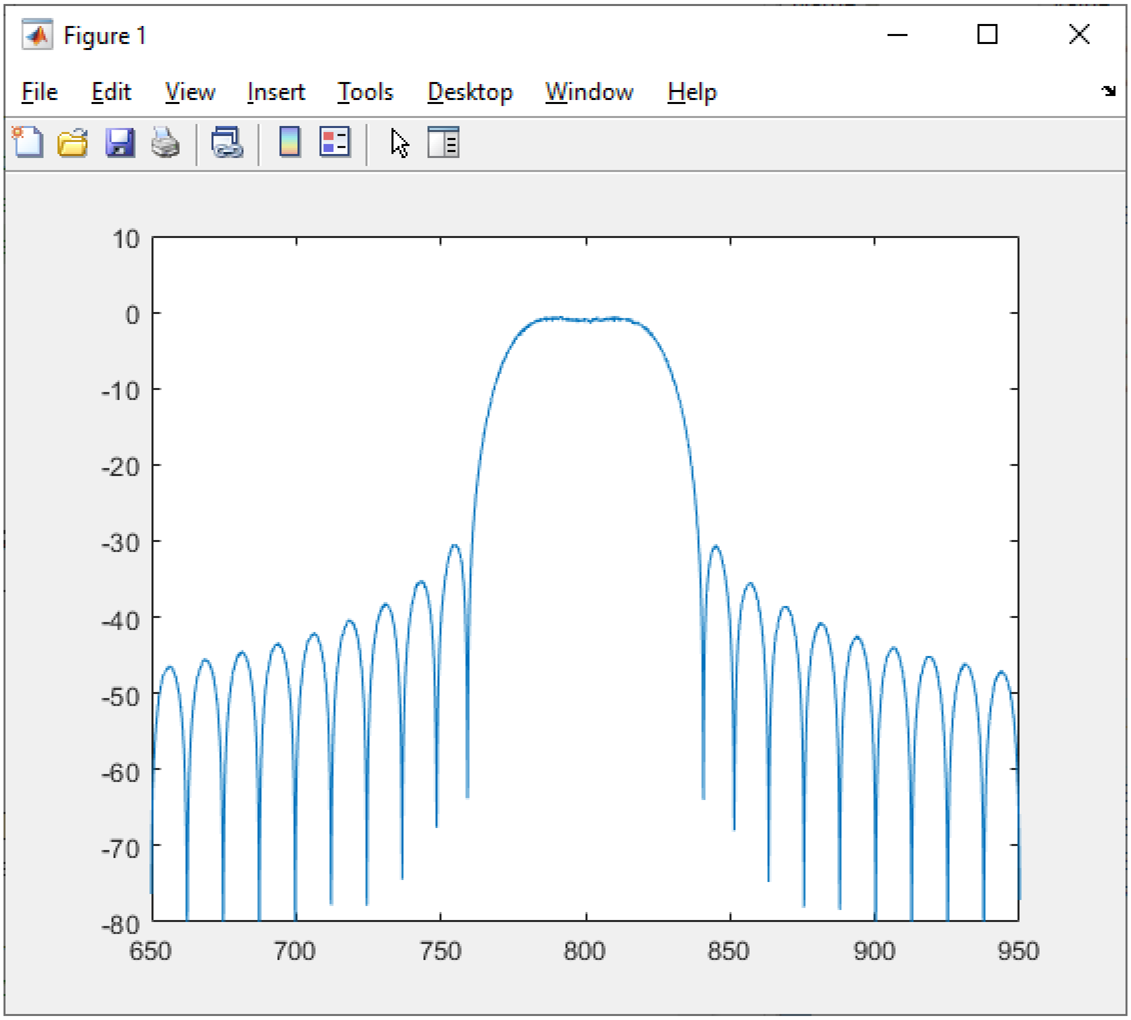


Figure 1
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T = 0.02

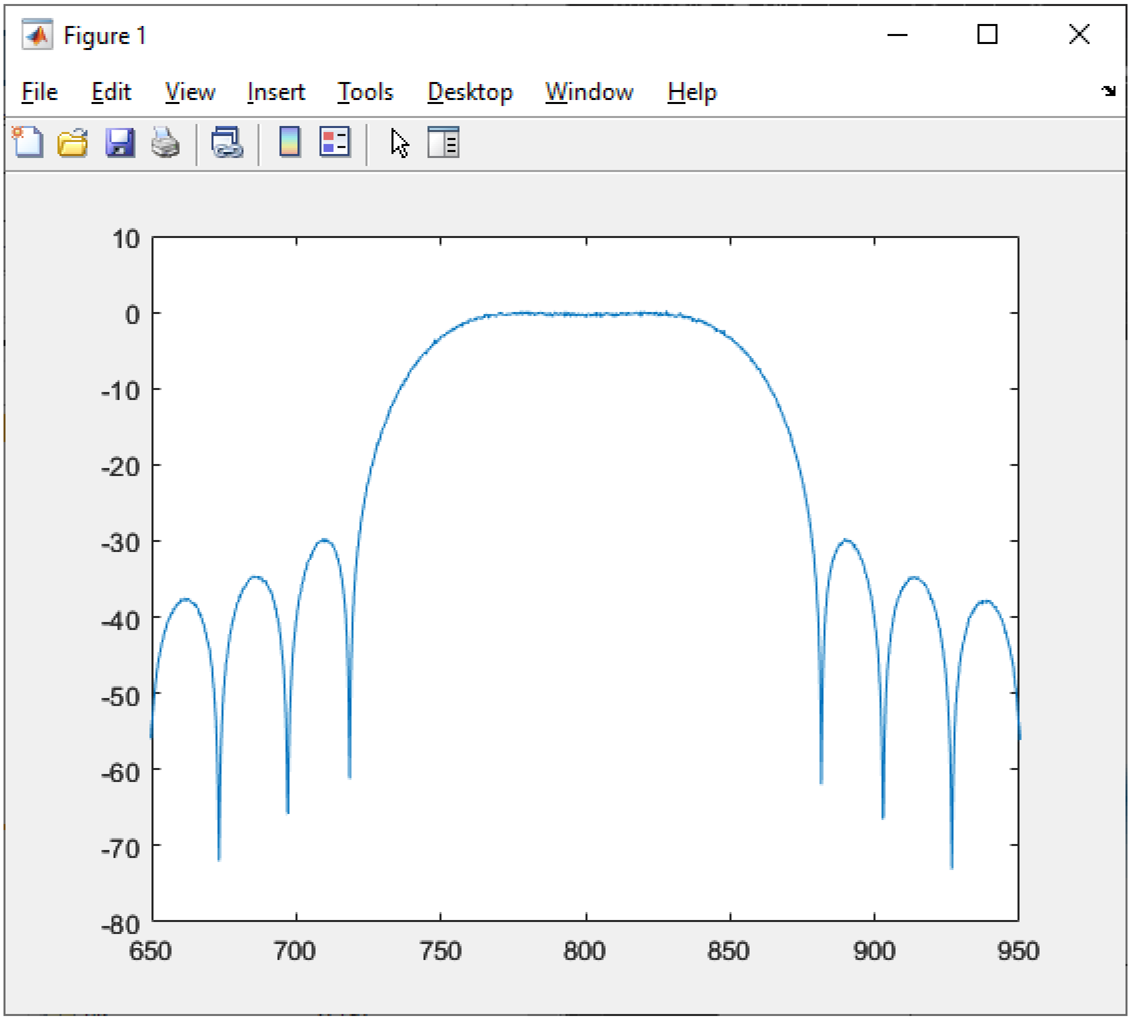

Figure 1
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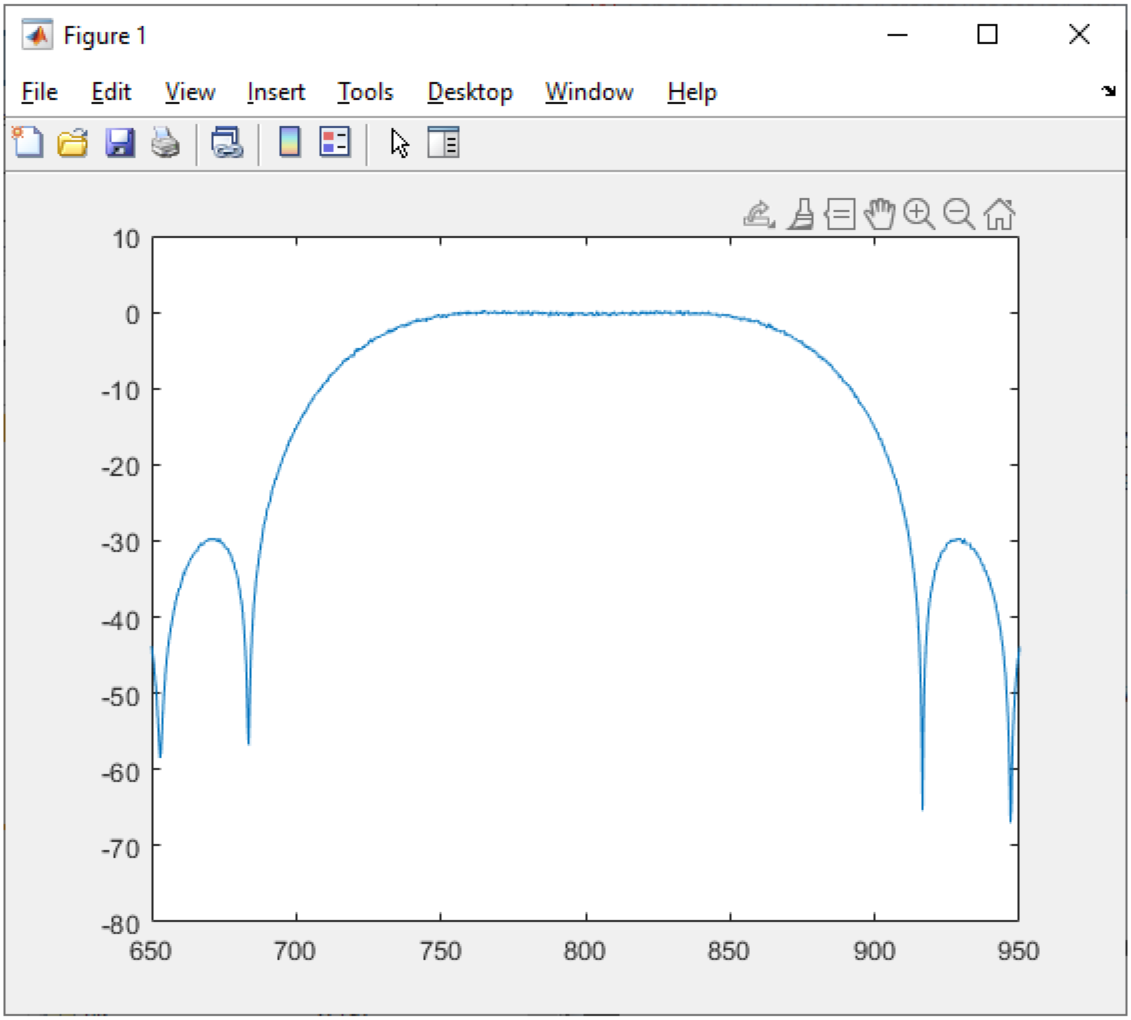
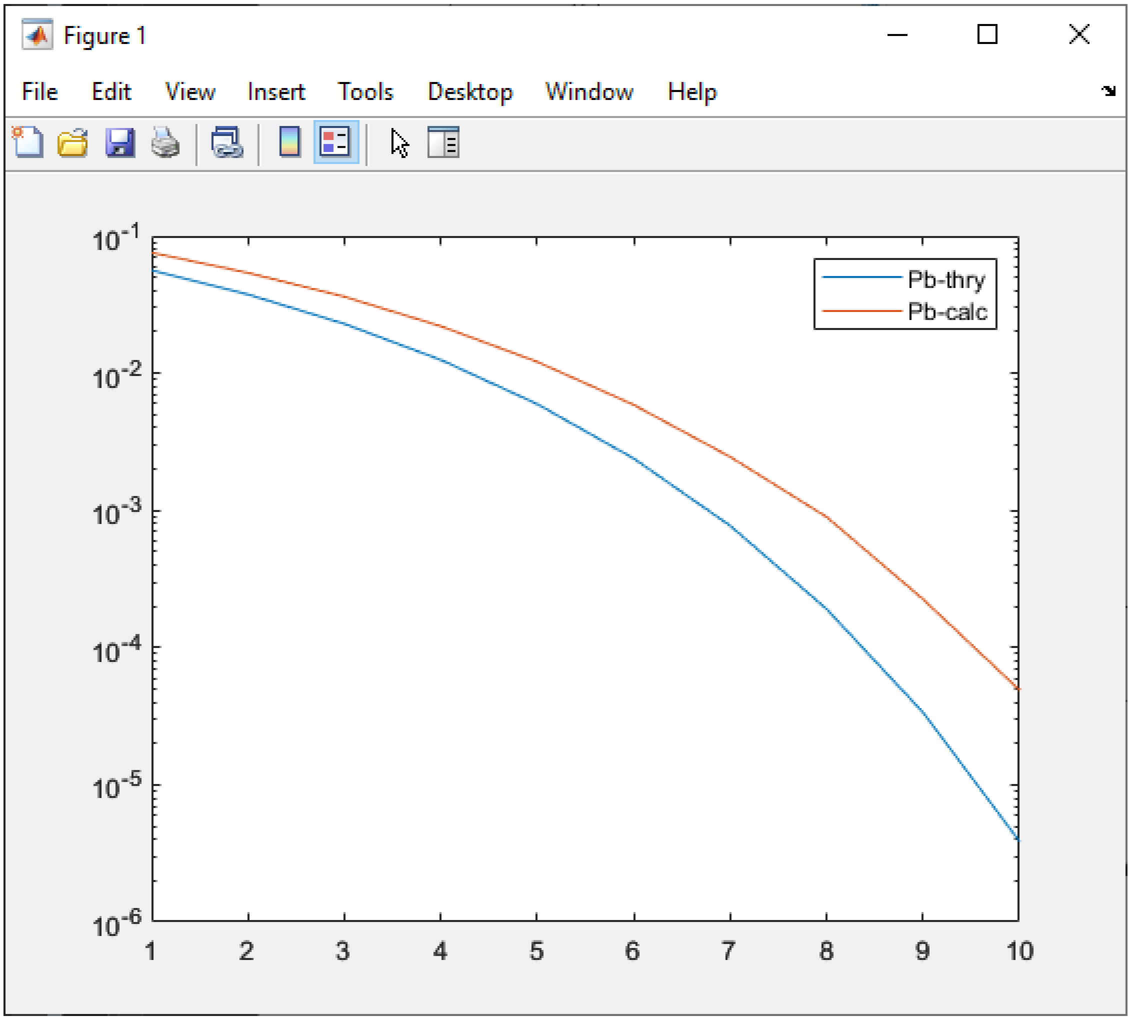
T = 0.01



T = 0.007

Part 2

Step 2: Modify your simulator to use a band-limited channel.



Step 3: Run your simulator with T=0.01, β=0.5, and L=4. Observe that the performance is nearly identical to the ideal case, while still having a throughput of 200 bits per second.

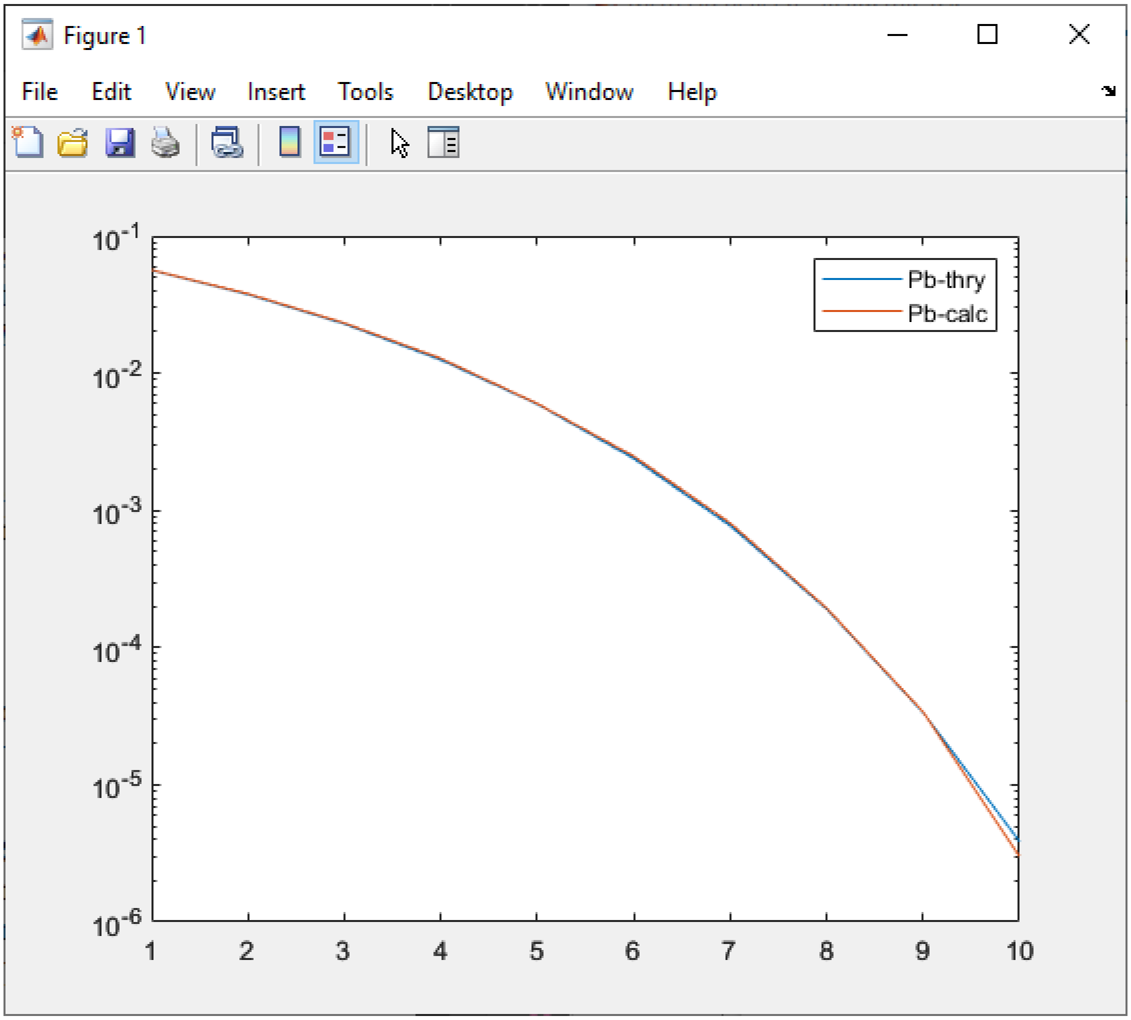


Figure 1
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Pb-thry
Pb-calc
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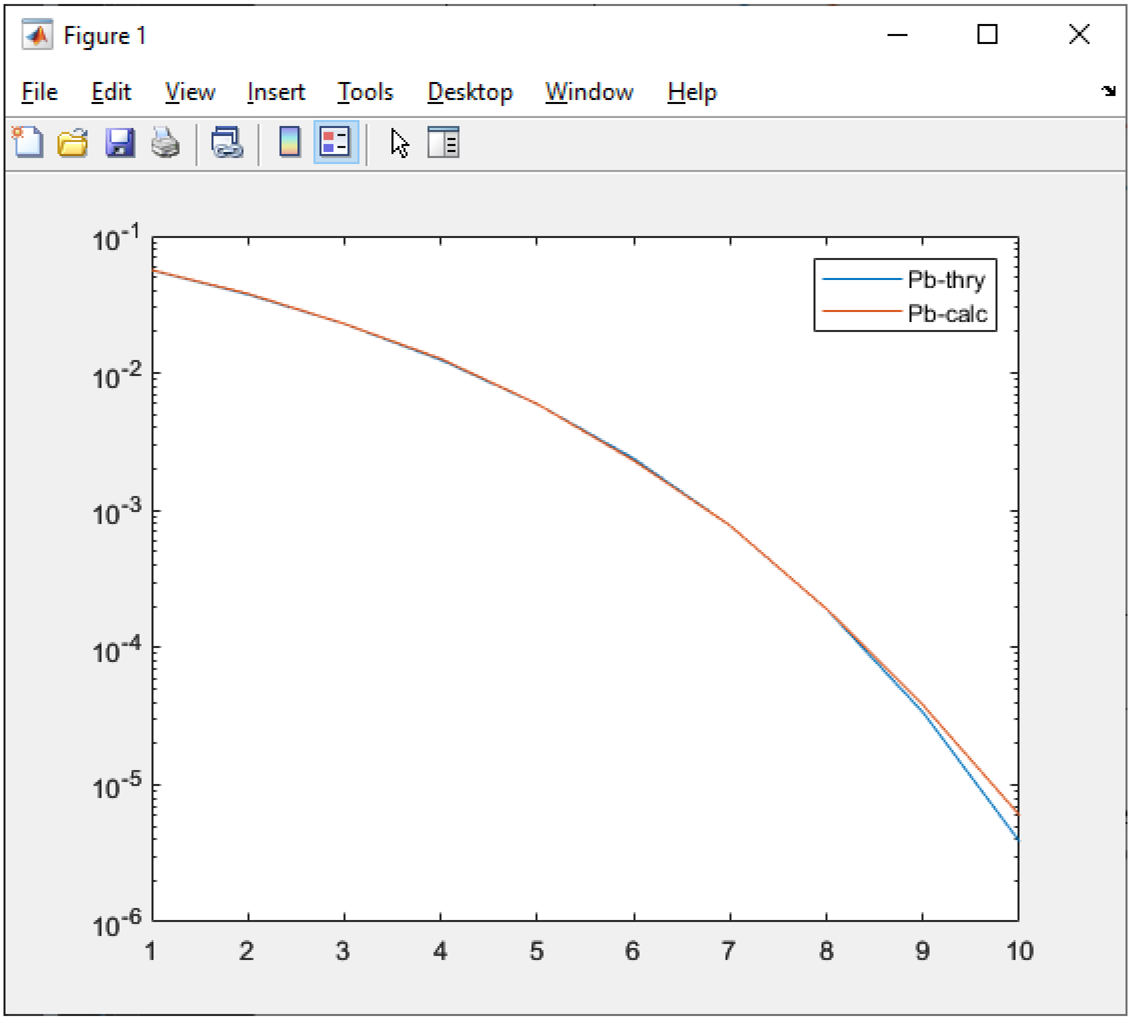

Figure 1
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Pb-thry
Pb-calc
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10^{-2}
10^{-3}
10^{-4}
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1 2 3 4 5 6 7 8 9 10