Lab Report 9

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Q1 (b)

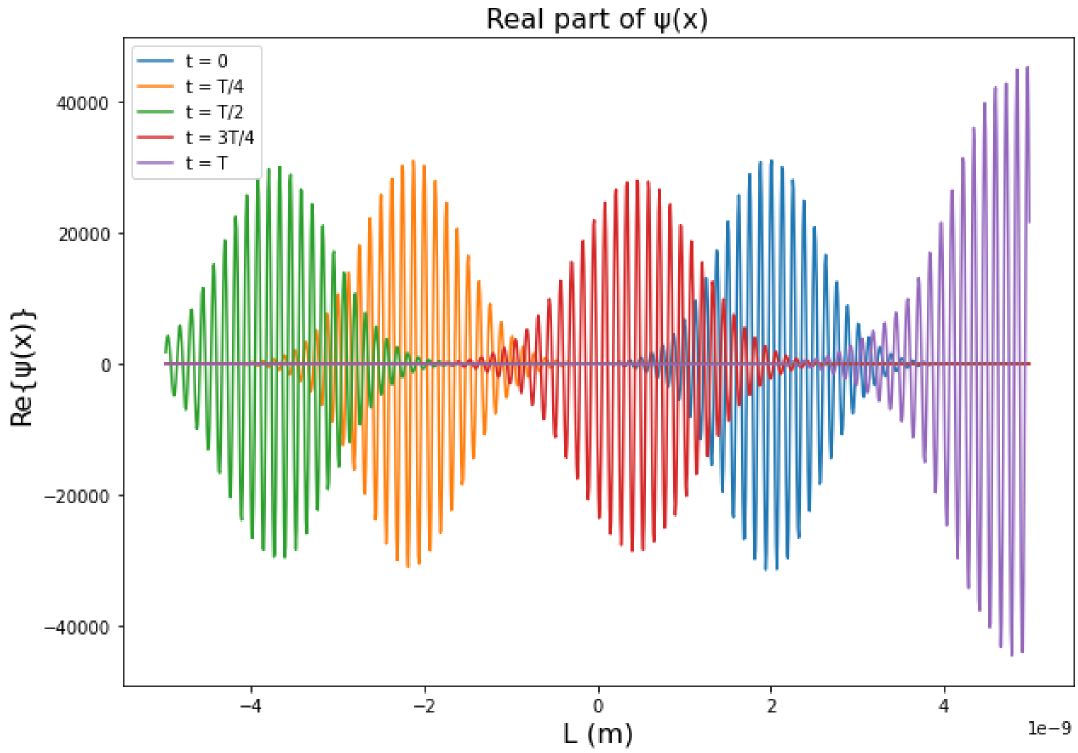

Figure 1: The real part of Ψ(x) at t = 0, T/4, T/2, 3T/4, T.

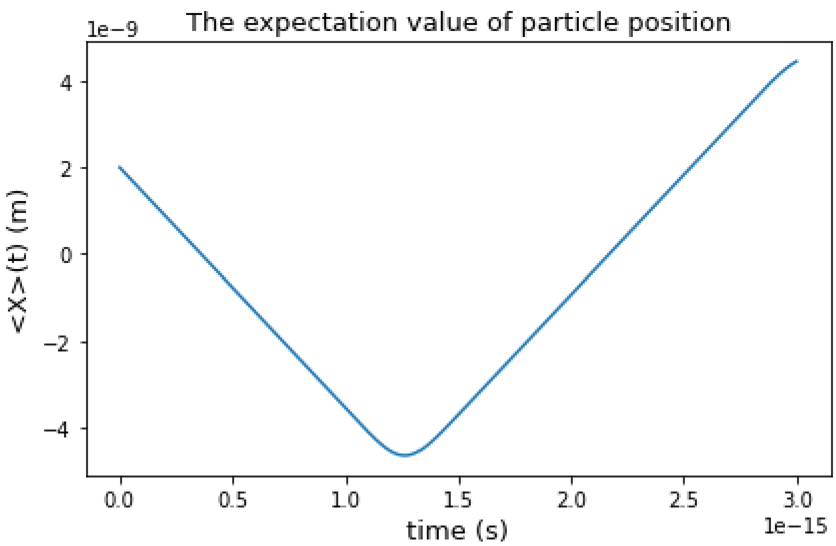

Figure 2: The expectation value of the particle's position from t = 0 to t = T.

Q1 (c)

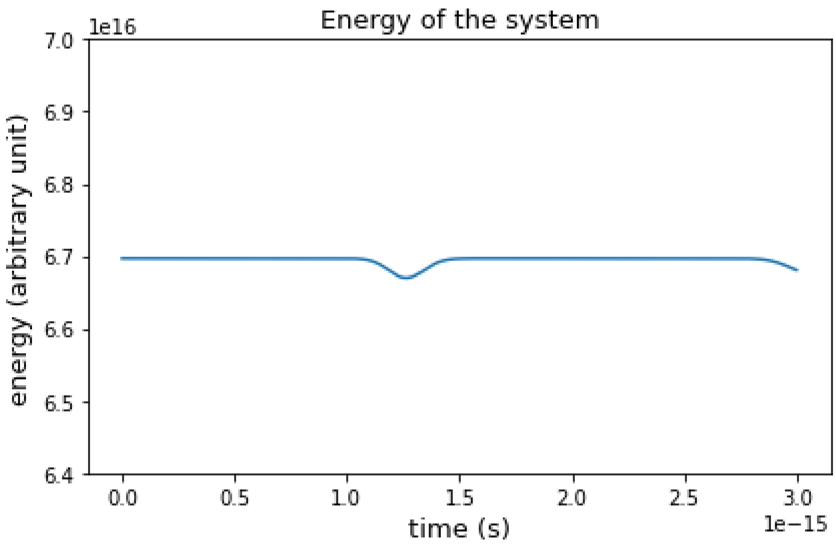

Figure 3: The energy of the system from t = 0 to t = T.

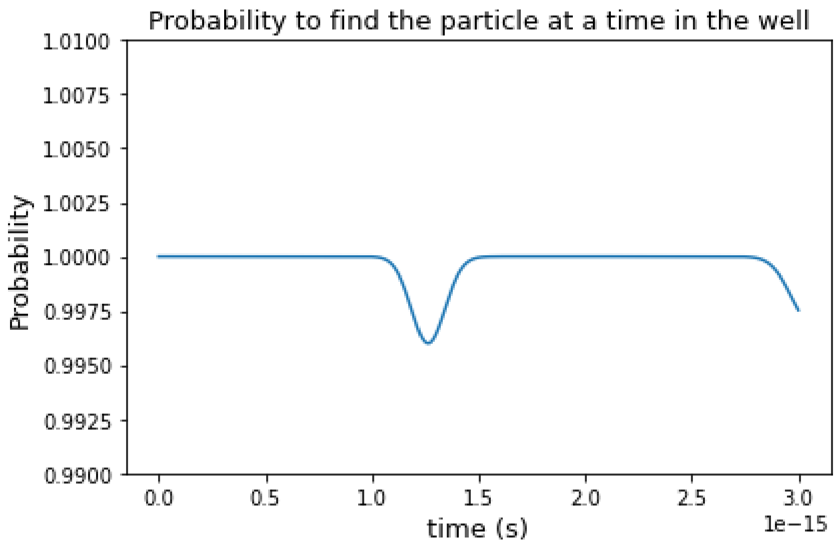

Figure 4: The probability of finding the particle in the well, the wave function remains normalized throughout t = 0 to t = T.

Q2 (a)

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The original 2D array is
[[0. 0. 0.]
 [0. 1. 1.]
 [0. 1. 1.]]
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Figure 5: The original 2D array for testing 2D Fourier transforms and their inverse.

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The inverse fourier transform of fourier transform of f is
[[ 0.00000000e+00 -1.48029737e-16 -1.48029737e-16]
 [ 0.00000000e+00  1.00000000e+00  1.00000000e+00]
 [ 0.00000000e+00  1.00000000e+00  1.00000000e+00]]
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Figure 6: The result of $f = F_{2D}^{-1}(F_{2D}(f))$, where F_{2D} is 2D Discrete Sine-Cosine Fourier transform

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The inverse fourier transform of fourier transform of f is
[[0. 0. 0.]
 [0. 1. 1.]
 [0. 1. 1.]]
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Figure 7: The result of $f = F_{2D}^{-1}(F_{2D}(f))$, where F_{2D} is 2D Discrete Cosine-Sine Fourier transform

Q2 (b)

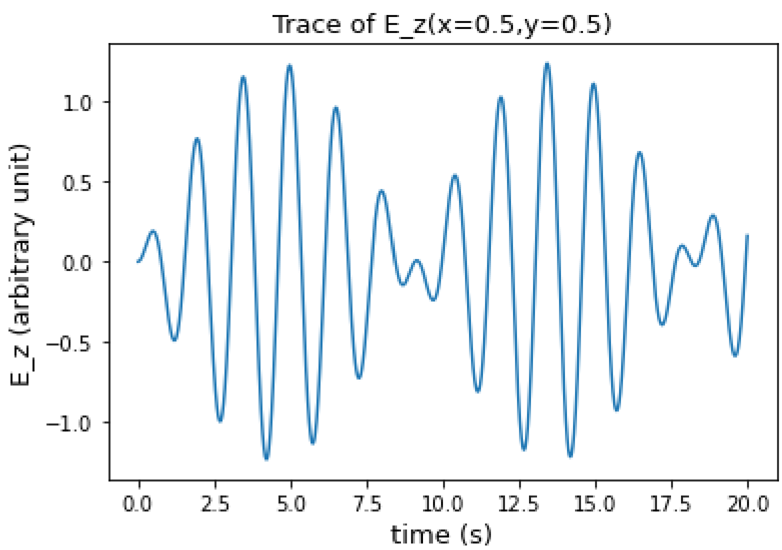

Figure 8: The trace of $E_z(x = 0.5, y = 0.5)$

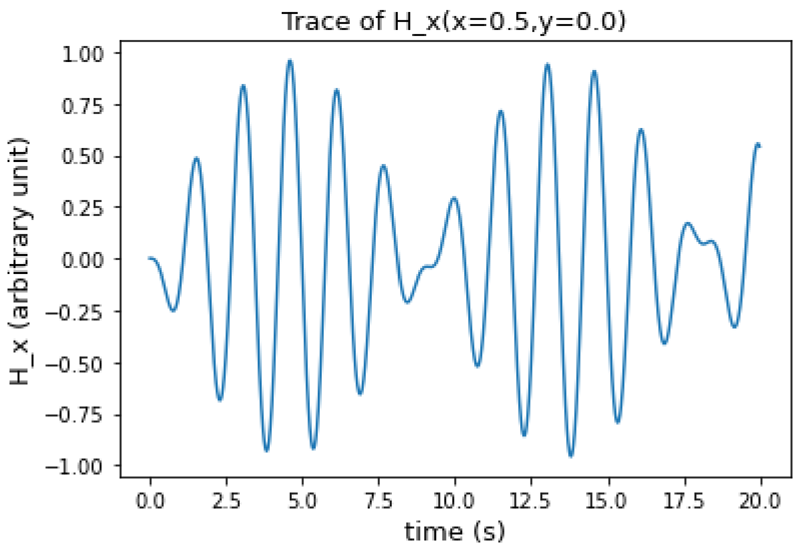

Figure 9: The trace of $H_x(x = 0.5, y = 0.0)$

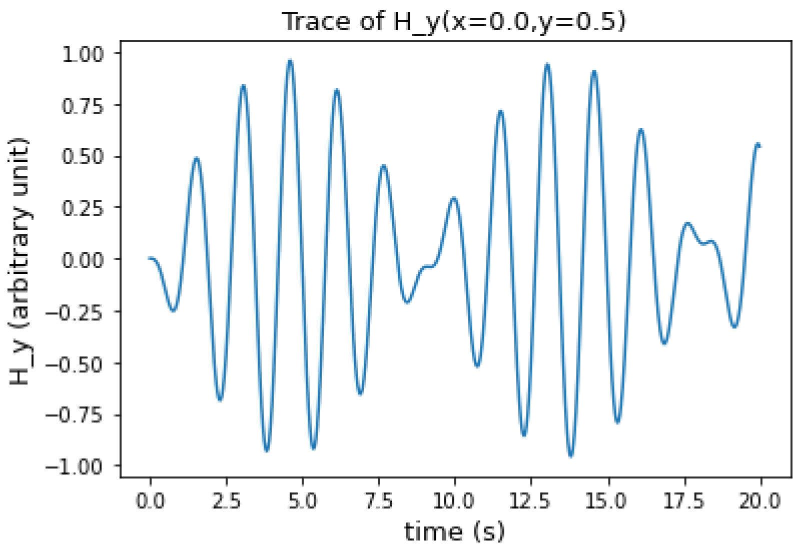

Figure 10: The trace of $H_y(x = 0.0, y = 0.5)$

Q2 (c)

From figures in Q2 (b), we can see that the electromagnetic fields, E_z, H_x, and H_y are the non-resonant case. In the cavity, the traces are taking a form of interference patterns and oscillate back and forth. Figure 9 and 10 shows the same traces due to the nature of symmetry; for $H_x(x_1 = 0.5, y_1 = 0.0)$ and $H_y(x_2 = 0.0, y_2 = 0.5)$, we can see that $x_1 = y_2$ and $y_1 = x_2$. From equation (15b) and (15c), with discretize space $(x_p, y_q) = (pa_x, qa_y)$, we can see that $\sin(\frac{p_1 p_1' \pi}{P}) \cos(\frac{q_1 q_1' \pi}{P}) = \cos(\frac{p_2 p_2' \pi}{P}) \sin(\frac{q_2 q_2' \pi}{P})$ for our given case of H_x and H_y. So it is expected that Figure 9 and 10 show the same traces.