ECE 462 - Homework #5a

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1 Package Imports

```
In [115]: import numpy as np
          from numpy import linalg as la
          import seaborn as sns
          import matplotlib.pyplot as plt
          from pylab import rcParams
          rcParams['figure.figsize'] = 16, 12
```

2 Constants

```
In [127]: del_x = 1e-10
          NN = 100

          DX = del_x * 1e9
          XX = np.arange(0, DX * NN, DX)

          hbar = 1.054e-34
          m0 = 9.11e-31
          ecoil = 1.6e-19
          eV2J = 1.6e-19
          J2eV = 1.0 / eV2J
          hbar_ev = hbar * J2eV
          chi0 = hbar ** 2 / (2 * m0 * del_x ** 2)
```

3 Create the $V(x)$ Potential

```
In [132]: V = np.zeros((NN))
          V[30:40] = 0.1 * eV2J
```

4 Create the Hamiltonian Matrix

```
In [133]: np.set_printoptions(precision=2)
          H = np.zeros((NN, NN))
          for diag in range(NN):
              H[diag, diag] = 2 * chi0 + V[diag] # Assign diagonals
```

```
    try:
        H[diag, diag + 1] = -chi0       # Assign col+1
    except IndexError:
        pass
    try:
        H[diag, diag - 1] = -chi0       # Assign col-1
    except IndexError:
        pass
    H[0, NN-1] = 0
```

5 Get the eps and phi arrays from the Hamiltonian Matrix

```
In [134]: eps, phi = la.eig(H)
```

6 Plot the Function and it's Eigenstates

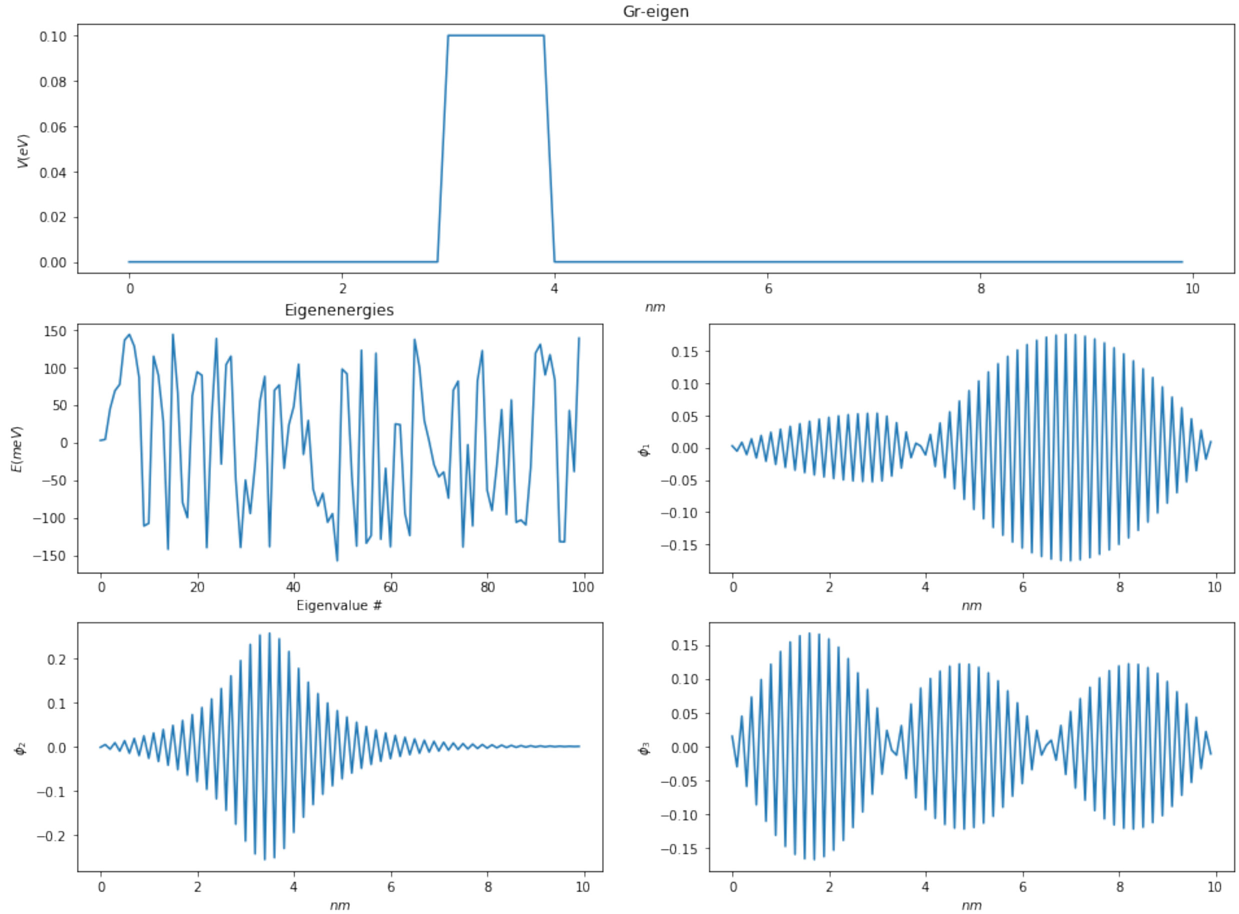
```
In [135]: plt.subplot(311)
          plt.title('Gr-eigen')
          plt.plot(XX, J2eV * V)
          plt.xlabel('$nm$')
          plt.ylabel('$V(eV)$')

          plt.subplot(323)
          plt.title('Eigenenergies')
          plt.plot(np.arange(NN), [1e3 * phi[m, m] for m in range(NN)])
          plt.xlabel('Eigenvalue #')
          plt.ylabel('$E (meV)$')

          plt.subplot(324)
          plt.plot(XX, phi[:, 0])
          plt.xlabel("$nm$")
          plt.ylabel("$\phi_1$")

          plt.subplot(325)
          plt.plot(XX, phi[:, 1])
          plt.xlabel("$nm$")
          plt.ylabel("$\phi_2$")

          plt.subplot(326)
          plt.plot(XX, phi[:, 2])
          plt.xlabel("$nm$")
          plt.ylabel("$\phi_3$");
```



Gr-eigen
V(eV)
nm
Eigenenergies
E(meV)
Eigenvalue #
ϕ_1
nm
ϕ_2
nm
ϕ_3
nm