ECE 462 - Homework #5a

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1 Package Imports

```
In [1]: import numpy as np
        from numpy import linalg as la
        import seaborn as sns
        import matplotlib.pyplot as plt
        from pylab import rcParams
```

2 Constants

```
In [2]: del_x = 1e-11
        NN = 1000

        DX = del_x * 1e9
        XX = np.arange(DX, DX * NN + DX, 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 [3]: V = np.zeros((NN))
        V[300:400] = 0.1 * eV2J
```

4 Create the Hamiltonian Matrix

```
In [4]: 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

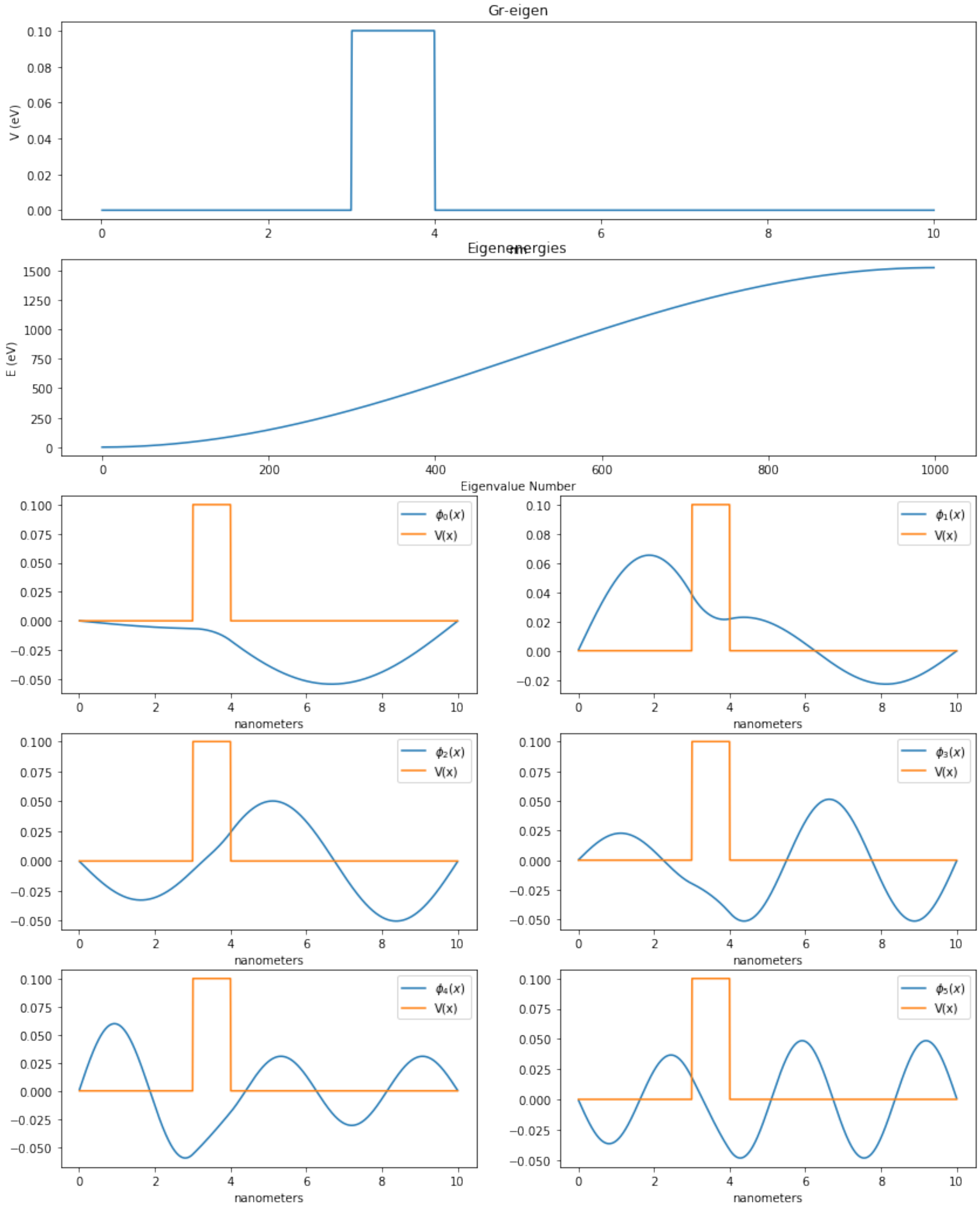
```
In [5]: eps, phi = la.eig(H)
        indices = np.argsort(eps)
```

6 Plot the Function and it's Eigenstates

```
In [6]: rcParams['figure.figsize'] = 14, 18
        plt.subplot(511)
        plt.title('Gr-eigen')
        plt.plot(XX, J2eV * V)
        plt.xlabel('nm')
        plt.ylabel('V (eV)')

        plt.subplot(512)
        plt.title('Eigenenergies')
        plt.plot(np.arange(NN), [J2eV * eps[indices][m] for m in range(NN)])
        plt.xlabel('Eigenvalue Number')
        plt.ylabel('E (eV)')

        for i in range(6):
            plt.subplot(5, 2, 2*2+1+i)
            plt.plot(XX, phi[:, indices[i]], label=r"$\phi_{}(x)$".format(i))
            plt.plot(XX, J2eV * V, label=r'V(x)')
            plt.ylabel('E (eV)')
            plt.xlabel("nanometers")
            plt.legend()
```


Gr-eigen
V (eV)
nm
Eigenenergies
E (eV)
Eigenvalue Number
$\phi_0(x)$
$\phi_1(x)$
$\phi_2(x)$
$\phi_3(x)$
$\phi_4(x)$
$\phi_5(x)$
V(x)
nanometers