Chapter 8 - Problem 5

In[ ]:=
```
(*Chapter 8 Problem 5 from the homework - Steph & Kelvin*)
Clear["Global`*"]
h = 6.62607004 * 10^-34;
m = 9.10938 * 10^-31;
ħ = h / (2 * Pi);
e = 1.60217 * 10^-19;
nano = 1 * 10^-9;
voltspernano = 1 / nano;
vo = -0.5; (* original depth of the 0.5 *)
L = 2 * nano; (* length of the potential well*)
Vext = 0.1; (* external bias*)
Uext = 0 - Vext;
F = Vext / L; (* electric field strength *)
```

In[ ]:=
```
zp[z_] = ((2 * m) / ħ^2)^(1/3) * (((vo - En) * e) / (e * F)^(2/3) - (e * F)^(1/3) * z);
zprime = D[zp[z], z]
```

Out[ ]=
$$-1.09483 \times 10^{9}$$

In[ ]:=
```
alpha = Sqrt[(2 * m * e) / ħ^2];
k1 = alpha * Sqrt[En];
k3 = alpha * Sqrt[En - Uext];
```

In[ ]:=
```
z0 = zp[0];
zL = zp[L];
```

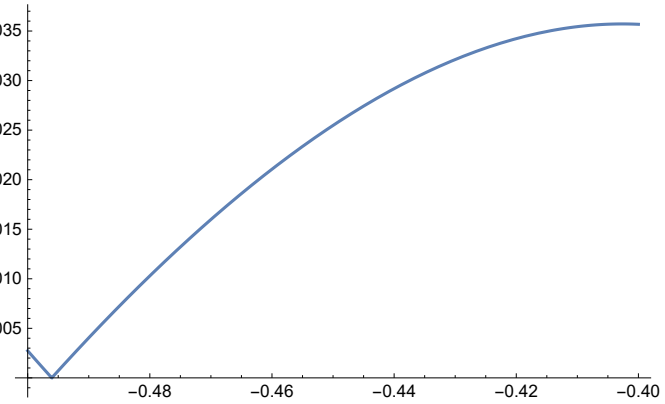
In[ ]:=
```
m1 = {{1, 1}, {I * k1, -I * k1}};
m2 = {{AiryAi[z0], AiryBi[z0]}, {zprime * AiryAiPrime[z0], zprime * AiryBiPrime[z0]}};
MatrixForm[m1];
w1 = Inverse[{{1, 1}, {I * k1, -I * k1}}].
   {{AiryAi[z0], AiryBi[z0]}, {zprime * AiryAiPrime[z0], zprime * AiryBiPrime[z0]}};
```

In[ ]:=
```
w2 = Inverse[
    {{AiryAi[zL], AiryBi[zL]}, {zprime * AiryAiPrime[zL], zprime * AiryBiPrime[zL]}}].
   {{Exp[I * k3 * L], Exp[-I * k3 * L]}, {I * k3 * Exp[I * k3 * L], -I * k3 * Exp[-I * k3 * L]}};
```

In[ ]:=
```
wT = w1.w2;
```

In[ ]:=
```
Plot[Abs[wT[[1, 1]]], {En, -0.4, -0.5}, PlotRange → All]
```

Out[ ]=



In[ ]:=
```
FindRoot[Abs[wT[[1, 1]]] == 0, {En, -0.49}]
```

FindRoot: The line search decreased the step size to within tolerance specified by AccuracyGoal and PrecisionGoal but was unable to find a sufficient decrease in the merit function. You may need more than MachinePrecision digits of working precision to meet these tolerances.

Out[ ]=
```
{En → -0.496053}
```