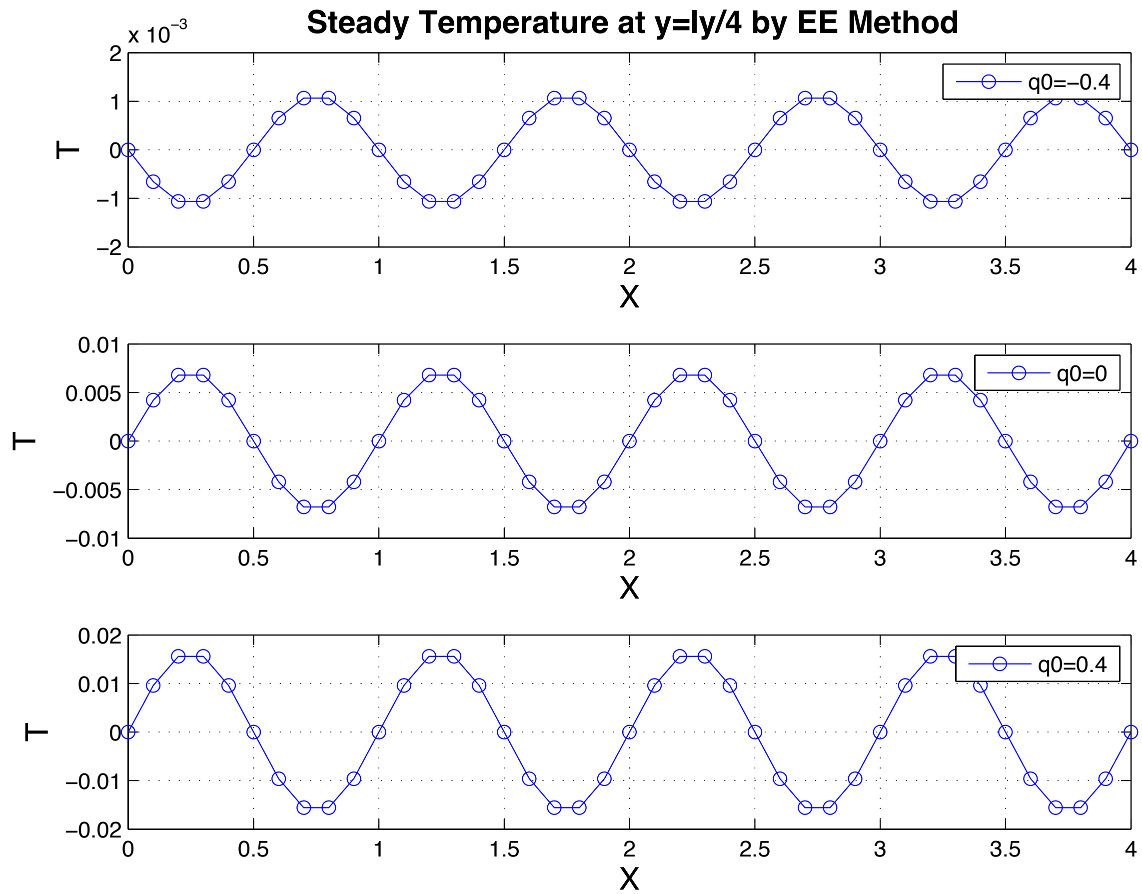
part b



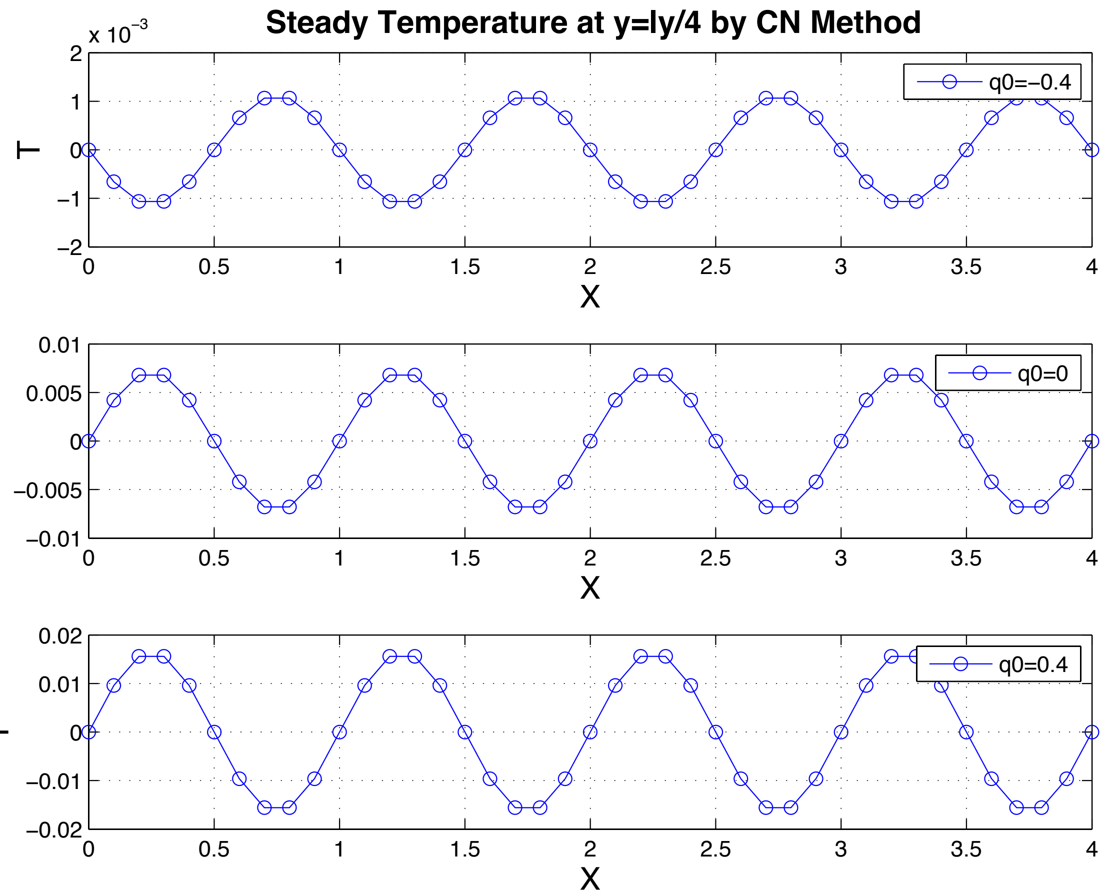
dt=0.01;

Time Step	q0=-0.4	q0=0	q0=0.4
EE	1276	1117	1276

Time Required	q0=-0.4	q0=0	q0
EE	12.76	11.7	12.76

According to the figure showed above, we can see that Explicit Euler method produces accurate steady-state results. It respectively takes 12.76s ,11.7s ,12.76s to reach steady state for q0=-0.4,0,0.4. It shows that the magnitude of T with q=0.04 is much larger than that of T with q0=-0.4. The reason is that when q is 0.04 a heat source is added to the heat equation. When q is -0.4 a heat sink is added to the heat equation.

partc



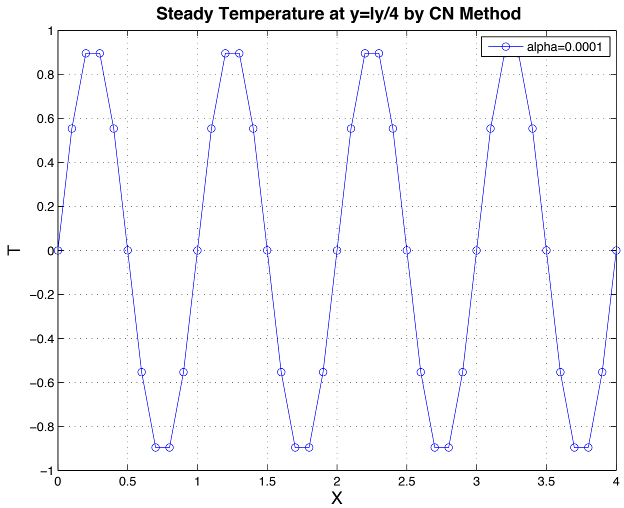
dt=0.01

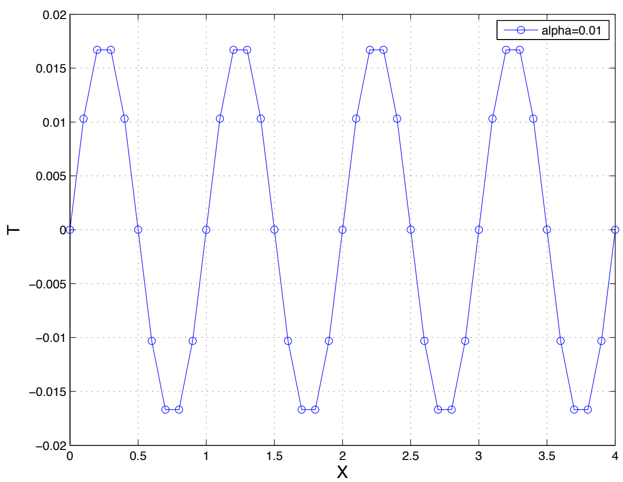
Time Step	q0=-0.4	q0=0	q0=0.4
EE	1276	1117	1276
CN	1278	1119	1279

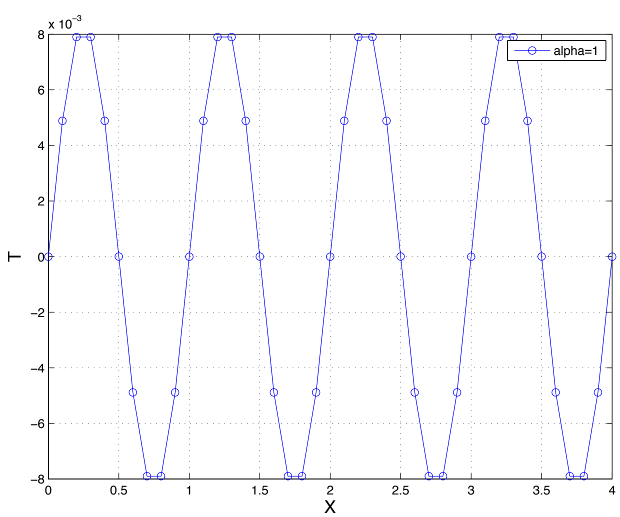
Time Required	q0=-0.4	q0=0	q0=0.4
EE	12.76	11.17	12.76
CN	12.78	11.19	12.79

The solutions of explicit Euler and Crank Nicolson method are approximately the same. And the number of time steps required to reach steady state for EE and CN method are approximately the same. But the Crank Nicolson method is unconditionally stable while the explicit Euler method is conditionally stable. So it's possible to use large time step in CN method. And it will remain stable. Moreover, the CN method is expected to be more accurate than the EE method since the CN method is 2nd order accurate while the explicit Euler method is 1st order accurate.

part d


Steady Temperature at y=ly/4 by CN Method
alpha=0.0001
T
X


alpha=0.01
T
X


x 10^-3
alpha=1
T
X

	Alpha=0.0001	Alpha=0.01	Alpha=1
Time steps	29	22	22
Time interval(s)	128	1.28	0.0128
Physical time(s)	3721	28.16	0.2816
T(x=lx/5,y=ly/4)	-0.8960	-0.0167	-0.0079

As Alpha increases, the time required reaching steady state decreases significantly. This matches with physical property. Since the greater the diffusivity number is, the faster the heat transfer is.