

1. Consider the following lattice model used to model graphene:

$$\hat{H} = -t \sum_{\langle i,j \rangle} \hat{c}_i^\dagger \hat{c}_j .$$

$\langle i, j \rangle$  means that only nearest neighbours are summed over on the hexagonal lattice.

- (a) What Bravais lattice does Graphene has, show there are two atoms in a unit cell which we can label  $A$  and  $B$ , and find a possible unit cell.
- (b) Write the Hamiltonian as a sum over every  $A$  site and a sum over the connections to the neighbours. What are the lattice vectors to the neighbouring sites?
- (c) Solve the system by Fourier transform and find the energies, plot the band structure.
- (d) For a periodic nanoribbon with zig-zag edges Fourier transform along the periodic direction and find the Hamiltonians as a function of this momenta.