Condensed Matter 232   WQ 2019

Prof. Sergey Syzranov   **Homework 4**
                                                                  Solve by 12 March 2019

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1. Electrons in a heterostructure form a 2D gas with the (two-dimensional) electron concentration n and the quasiparticle mass $m^* = 0.01 m_e$. Using lithography, it is possible to create a narrow "bridge" in this 2D electron gas, which connects two broad "shores" A and B, as shown in the figure. The width of the bridge is $d \approx 1\mu m$. At what minimal electron density n does the bridge conduct?
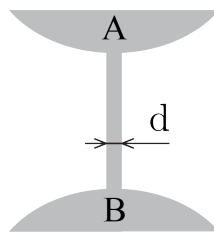
2. Derive Landau levels (i.e. the eigenenergies of quasiparticles in magnetic field) in graphene.

Hint: consider the equation $\hat{\mathcal{H}}^2 \Psi = E^2 \Psi$, where $\hat{\mathcal{H}} = v\hat{\boldsymbol{\sigma}} \cdot \left(\mathbf{k} - \frac{e}{c}\mathbf{A}\right)$ is the Hamiltonian of long-wave quasiparticles in graphene, and use Landau gauge.