Nanoelectronics Workshop 2
14:00-15:00 on Friday, 05/02/2021 (online)
To be handed in by 12:00 on Thursday, 18/02/2021 via VLE
Note: 12.5% of Final Mark (50% from Workshops and 50% from Final Examination)

Feedback:
Question 1 is answered very well. Please make sure to provide enough details of your calculations.

Question 2 seems to be the most difficult one in the workshop 2. As I explained in the workshop, you need to plot the probability at the beginning and the wave function at the end. Some of you seem to struggle to rearrange the integral to

$$\psi(x, t) = \int_{-\infty}^{+\infty} \frac{dk}{2\pi} A(k) e^{ikx}$$

$$= \frac{1}{2\pi} \exp\left(-\frac{x^2}{2a} + i k x\right) \int_{-\infty}^{+\infty} \exp\left(-\frac{a}{2} (k - k_0 - i \frac{x}{a})^2\right) dk$$

which allows you to use $\int_{-\infty}^{+\infty} \exp(-ax^2)dx = \frac{\sqrt{\pi}}{\sqrt{a}}$ ($a > 0$).

There are some minor mistakes in Questions 3. Please note that the normalisation should be done by integrating the wave function within the region it exists as shown below.

$$\int_{0}^{L} |\varphi_n(x)|^2 dx = \int_{0}^{L} \left\{ B^2 \sin^2 \left(\frac{n\pi}{L} x\right) \right\} dx$$

$$= B^2 \int_{0}^{L} \left(1 - \cos\left(\frac{2n\pi}{L} x\right) \right) \frac{1}{2} dx$$

$$= B^2 \int_{0}^{L} \left(\frac{1}{2} - \frac{1}{2} \cos\left(\frac{2n\pi}{L} x\right) \right) dx$$

$$= B^2 \left[\frac{1}{2}x - \frac{1}{4} \cdot \frac{L}{2n\pi} \sin\left(\frac{2n\pi}{L} x\right)\right]_{0}^{L}$$

$$= B^2 \frac{L}{2} = 1$$
\[ \therefore B = \frac{\sqrt{2}}{L} \]

This leads to the wave function:

\[ \varphi_n(x) = \frac{\sqrt{2}}{L} \sin \left( \frac{n\pi}{L} x \right). \]