UNIVERSITY of York

Department of Electronic Engineering

Assessments 2019/20

ELE00023H

Nanoelectronics

This assessment (**Tutorial Questions 2**) contributes **13%** of the assessment for this module.

Clearly indicate your **Exam Number** on every separate piece of work submitted.

Unless the assessment specifies a group submission, you should assume all submissions are individual and therefore should be your own work.

All assessment submissions are subject to the Department's policy on plagiarism and, wherever possible, will be checked by the Department using Turnitin software.

Submission is via **the VLE** and is due by **12:00** on **13 February 2020 (Spring Term, Thursday, Week 6)**. Please try and submit early as any late submissions will be penalised.

Please remember that if this is your first year of study, you need to complete the mandatory Academic Integrity Tutorial http://www.york.ac.uk/integrity/

19/20 Nanoelectronics: Tutorial Questions 2

Question 1.

An electron travelling in one dimension can be represented by the wave

$$\psi = A\exp\{i(kx - \omega t)\},$$

where A is a constant, k is a wave number, x is travelling distance, ω is angular frequency and t is time. Calculate the group velocity g of the electron and show that it equals the particle velocity v.

Question 2.

In order to describe particle-wave duality, de Broglie's wave can be used.

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

where A is a constant, k is a wave number, x is travelling distance, ω is angular frequency and t is time. Here, the relationship between k and $A(k)$ is as follow:

$$A(k) = e^{-\alpha(k-k_0)^2/2},$$

where α is a positive constant. Derive the time-independent wavefunction.

Question 3.

An electron with the mass of *m* travels in a one-dimensional potential given by

$$V(x) = \begin{cases} 0 & (0 \le x \le L) \\ +\infty & (x < 0 \; and \; L < x) \end{cases}.$$

Derive the energy eigenvalues and the corresponding normalised wavefunction.