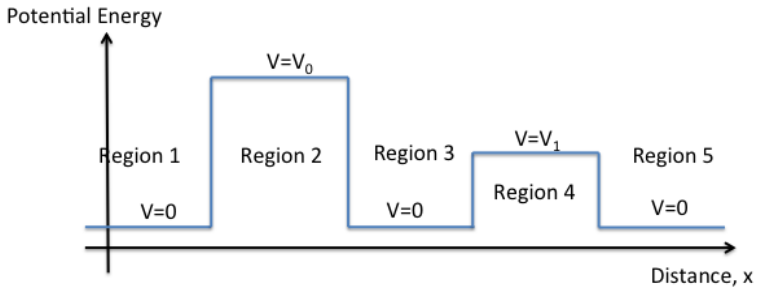
Part 1B Paper 8: Electrical Engineering Elective
Examples paper covering Lectures 2-5

1.) What is the velocity of an electron having wavelength 72.8nm? What is the kinetic energy of the electron in eV? **[Section 2]**

2.) What is the energy of a photon having wavelength 700nm? **[Section 2]**

3.) Write Schrodinger's equation for the wave-particle in each of Regions 1-4. **[Section 3.1]**



4.) X-rays of wavelength 50 pm undergo a first-order (i.e. $n = 1$) reflection at a glancing angle of 10° from a crystal. Find the spacing, d of the atomic planes in the crystal. **[Section 4.2]**

5.) The energy gap in a semiconductor is $45k_BT$ at any temperature T. If the intrinsic carrier concentration at 300K is $10^{10}/cm^3$, find the intrinsic carrier concentration in the semiconductor at 100K. **[Section 5]**

6.) Crystalline silicon has as an electron and hole mobility of 1000 cm^2/Vs and 500 cm^2/Vs, respectively. The free carrier concentration in intrinsic silicon is $10^{10}/cm^3$. This intrinsic silicon is then doped with $N_A=10^{14}/cm^3$ acceptor dopants.
(a) What is the resistivity of the intrinsic silicon?

(b) What is the resistivity of the doped silicon? **[Section 6]**

7.) A semiconductor is doped n-type with $10^{15}/cm^3$ donor dopants. The intrinsic carrier concentration is $10^{10}/cm^3$. The effective mass of the electron in the semiconductor is 0.4 times the electron mass in vacuum. The mean collision time is 0.2ps. Find the resistivity of the doped semiconductor. **[Section 6]**

Numerical answers:

1. 10^4 m/s; $2.8x10^{-4}$ eV
2. 1.77 eV

4. 0.143 nm
5. $5.19 \times 10^{10}/cm^3$
6. (a) 416,666 Ω cm; (b) 12.5 Ω cm
7. 7.1 Ω cm

C. Durkan

April 2024