Chulalongkorn University

Department of Electrical Engineering

2102-385 Semiconductor Devices I

Academic Year 2557, Semester II

Mid-Term Examination

Instruction

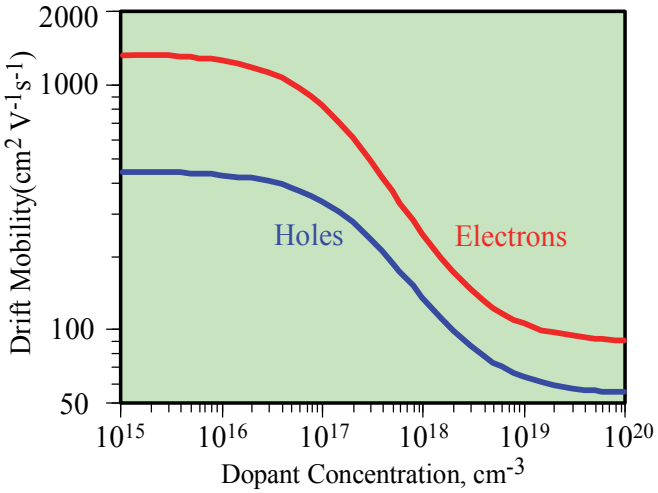
1. This is a closed-book examination.
2. Only non-programmable calculators are allowed. A formulae sheet is provided.
3. The marks are different for different questions; manage your time accordingly.
4. Use the following constants in your calculation:

Avogadro's number	$N_A = 6.02\times10^{23}$ molecules / mole
Boltzmann's constant	$k_B = 1.38 \times 10^{-23}$ J/K
Electronic charge	$e = -1.6 \times 10^{-19}$ C
Electronic rest mass	$m_0 = 9.11 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-14}$ F/cm
Planck's constant	$h = 6.63 \times 10^{-34}$ J-s
Speed of light	$c = 3 \times 10^{8}$ m/s

5. Use the following parameters for **Silicon**:

Energy gap	$E_G = 1.12$ eV
Relative permittivity	$\varepsilon_r = 11.8$
Lattice constant	5.43 Å
Density	2.33 g/cm^3
Atomic weight	28.1 (g/mol)
Intrinsic electron concentration	$n_i = 10^{10}$ cm^{-3} at 300K

Minority carrier (recombination) lifetime $\tau = \dfrac{1}{\alpha(n_0 + p_0)}$ where $\alpha = 10^{-12}$ cm^3/s, n_0 and p_0 are equilibrium electron and hole concentrations, respectively



The variation of the drift mobility with dopant concentration in Si for electrons and holes

The electron and hole mobilities at 300K as shown in the graph on the left-hand side can also be expressed as:

$$\mu_n = 88 + \frac{1252}{1 + 0.698\times10^{-17} N} \text{ cm}^2/\text{V}\cdot\text{s}$$

$$\mu_p = 54.3 + \frac{407}{1 + 0.374\times10^{-17} N} \text{ cm}^2/\text{V}\cdot\text{s}$$

where N is the dopant concentration in cm^{-3}.