Chulalongkorn University
Faculty of Engineering | Department of Electrical Engineering
2102385 Semiconductor Devices I | Final Examination

Instruction:

1. This is a closed-book exam.
2. Programmable calculators must be reset.
3. Answer in the Answersheets provided.
4. Note that the ratio of marks given to **Q1:Q2:Q3:Q4** is **30:30:20:20**.
5. Use the following information for your calculation:

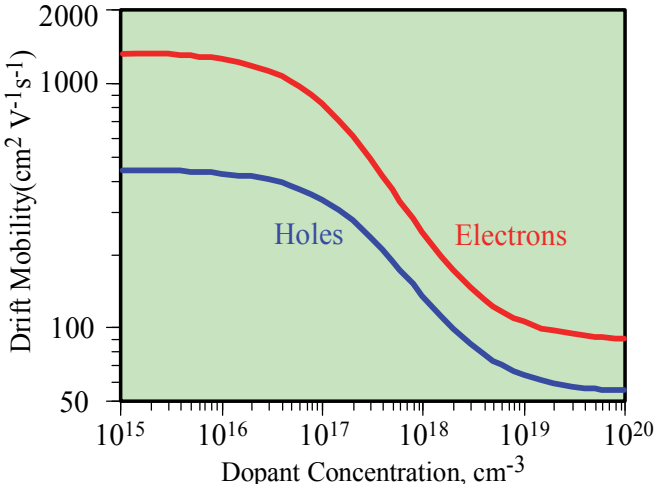
Avogadro's number	$N_A = 6.02\times10^{23}$ molecules / mole
Boltzmann's constant	$k = 1.38 \times 10^{-23}$ J/K
Electronic charge	$e = -1.6 \times 10^{-19}$ C
Electronic rest mass	$m_0 = 9.11 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-14}$ F/cm
Planck's constant	$h = 6.63 \times 10^{-34}$ J-s
Speed of light	$c = 3 \times 10^{8}$ m/s
Thermal voltage at 300 K	$kT/e = 0.026$ V

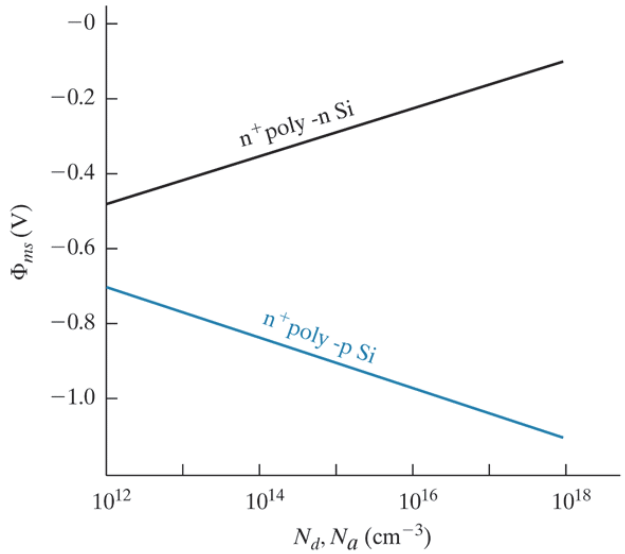
For Silicon (Si):

Energy gap	$E_G = 1.12$ eV
Relative permittivity	$\varepsilon_r = 11.8$
Intrinsic carrier conc.	$n_i = 10^{10}$ cm^{-3} at 300K
Density	2.33 g/cm^3

For Silicon dioxide (SiO_2):

Relative permittivity	$\varepsilon_r = 3.9$





☜ Electron and hole mobilities at 300K. These can also be calculated from:

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

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

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

For Si: Minority carrier lifetime

$$\tau = \frac{1}{B(n_0 + p_0)} \text{ where } B = 10^{-12} \text{ cm}^3/\text{s}$$

☜ Work function difference (Φ_{ms}) between n^+-poly silicon and silicon as a function of doping concentration.These can also be calculated from:

$$\Phi_{ms} = -0.48 + \frac{0.38}{6}\log\left(\frac{N}{10^{12}}\right) \text{ volts}$$

for n^+-poly – n-Si, and

$$\Phi_{ms} = -0.70 - \frac{0.40}{6}\log\left(\frac{N}{10^{12}}\right) \text{ volts}$$

forn^+-poly – p-Si,where N is the doping concentration of the substrate in cm^{-3}.