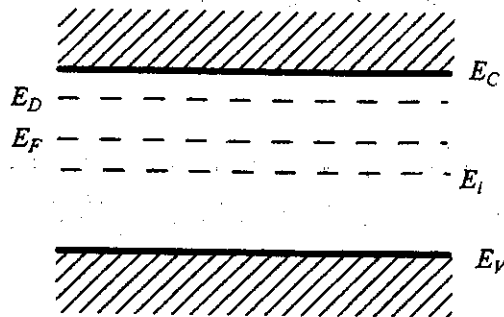1. A simple energy band diagram for silicon doped with 10^{16} arsenic atomes/cm³ at 300K is shown below. Calculate the electron and hole concentrations and determine the energy levels of donor, Fermi level and intrinsic Fermi level with respect to the conduction energy level E_C. (20 分)

2. Starting with an n-type substrate, draw the necessary intermediate processes for the fabrication of a pMOS shown below. How many masks are needed for the complete fabrication? (20 分)
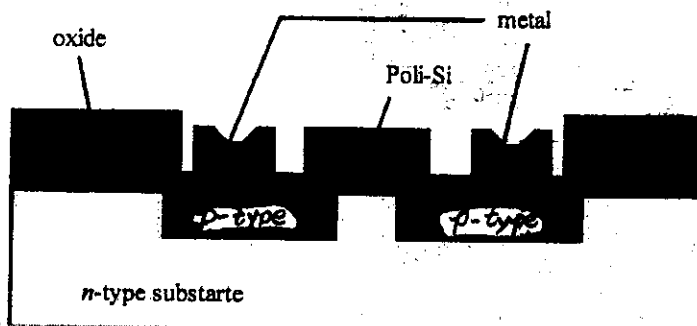
3. A 0.25-μm-thick single-crystal Si sample is illuminated at 300 K with a monochromatic light having an $h\nu$ of 3 eV. The incident power is 10 mW. Find the total energy absorbed by the semiconductor per second, the power dissipated to the lattice and the number of photons per second given off from recombination by the intrinsic transition. The photon flux distribution in Si can be assumed as the form shown in the diagram below. (20 分)
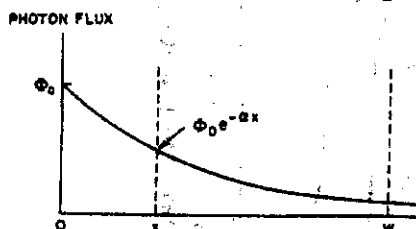
4. Consider a MOS system using n+ polysilicon as the gate material on the top of a p-type substrate which is doped with Na = 3×10^{16} cm⁻³. Assume the oxide charge Q_{ox} is 10^{11} cm⁻² and the space charge density is 8.64×10^{-8} C/cm². What is the oxide thickness such that it will have +0.65 V as the threshold voltage? (work function $\phi_{ms} = -1.13V$, $T = 300$ K) (20 分)

（背面仍有題目,請繼續作答）

5. For a silicon pn junction under forward bias at 300 K with doping concentration $N_a = 10^{16}$ cm^{-3} and $N_d = 10^{15}$ cm^{-3}. Sketch both majority and minority carrier current in this pn junction. Please also indicate the space charge widths for both sides. (20 分)

Some data may be useful for the examination:

At 300K, $kT = 0.0259$ eV, bandgap of Si = 1.12 eV, intrinsic carrier density of Si = 1.5×10^{10} cm^{-3}, dielectric constant of Si = 11.7, dielectric constant of SiO$_2$ = 3.9.

$\varepsilon_0 = 8.85 \times 10^{-14}$ F/cm

Measured ionization energies for various impurities in Si in unit of eV

Optical absorption coefficient