1. Inside a certain device, electrons with energy 3 eV are incident on a uniform potential energy barrier with 7 eV in height and 1 nm in width. Find the fraction of the electrons that can transmit through this barrier (10%)

2. Assume the cube edge of the conventional cell in a fcc lattice is 1 nm. Calculate the surface density of atoms for the (100) plane. (10%)

3. Fig. 1 is the band structure of a certain semiconductor. Which curve (A, B, C, or D) is heavy holes? Which curve is light holes? Explain your answer. (10%)

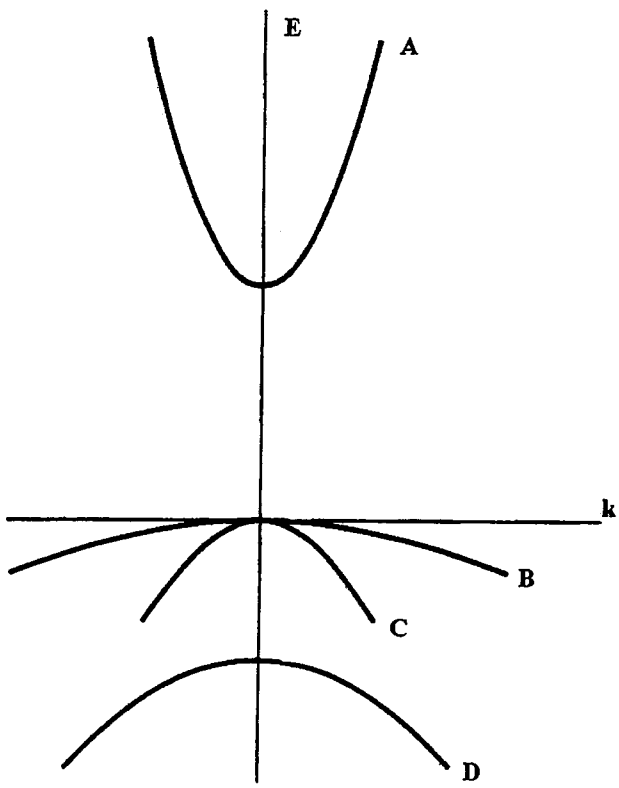

Fig. 1

4. For a silicon at room temperature (kT=0.0259 eV), it doped with 10^{15} arsenic atoms/cm^3 on one side and doped with 10^{16} boron atoms/cm^3 on the other side to form an abrupt p-n junction. Calculate the build-in potential, depletion region length for both n and p sides, and also draw the energy band diagram at thermal equilibrium indicating Fermi level, conduction and valence bands for this p-n junction.

(use $n_i = 10^{10}$ /cm^3, Si dielectric constant 11.8 and permittivity $\varepsilon_0 = 8.85 \times 10^{-14}$ F/cm)

(背面仍有題目,請繼續作答)

5. (a) For a P^+NP device indicate the voltage polarity (+ or -) for the following operation regions: (10%)

Region	V_{EB}	V_{CB}
Active		
Saturation		
Cutoff		
Inverted active		
Inverted saturation		

(b) Sketch the minority carrier distribution in P^+, N, and P regions for an ideal P^+NP transistor under active mode of operation. (10%)

6. For a metal-SiO_2-Si capacitor having N_A=5×10^{16} cm^{-3} and d=8nm, calculate the minimum capacitance on the C-V curve. (Thickness of SiO2 d; dielectric constant of Si 11.9; dielectric constant of SiO_2 3.9; ε_o=8.85×10^{-14} F/cm; kT/q ~ 0.026 V, intrinsic carrier density of Si n_i =9.65×10^9 cm^{-3}) (10%).

7. Consider a long-channel MOSFET with a channel length L= 1 μm, a channel width Z=10 μm, substrate doping N_A=5×10^{16} cm^{-3}, μ_n=800 cm^2/V-s, the oxide capacitance per unit area C_o =3.45×10-7 F/cm^2, and the threshold voltage V_T=0.7 V. Find the saturation drain voltage and current V_{Dsat} and I_{Dsat} for applied gate voltage V_G=5V. (20%)