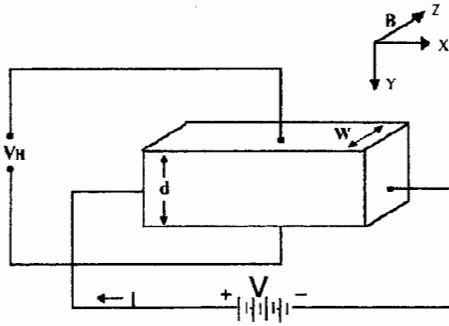


※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. If we pack hard spheres in a bcc lattice such that the atom in the center just touches the atoms at the corners of the cube, find the fraction of the bcc unit cell volume filled with spheres. (8%)

2. Given a semiconductor sample with unknown doping, Hall measurement has been made and the following information obtained;  $d = 0.05$  cm,  $A = d \times W = 1.6 \times 10^{-3}$  cm<sup>2</sup>,  $I = 2.5$  mA, and the magnetic field  $B$  is 30 nT ( $1\text{T} = 10^4$  Wb/cm<sup>2</sup>). If a Hall voltage of +10 mV is measured, find the Hall coefficient, conductivity type, majority carrier concentration, resistivity, and mobility of the semiconductor sample. (12%)



3. Consider a Si  $p-i-n$  structure where the  $i$  region is intrinsic. The doping of  $p$  region is  $10^{15}$  cm<sup>-3</sup>; the doping of  $n$  region is  $10^{16}$  cm<sup>-3</sup>. If the lengths of  $p$ ,  $i$ ,  $n$  region are 2  $\mu\text{m}$ , 1  $\mu\text{m}$ , and 2  $\mu\text{m}$ , respectively, find the depletion layer width for this structure at  $T = 300$  K. (15%)
4. An n-channel MOSFET with 10 nm gate oxide thickness has threshold voltages of 0.6 V at  $V_{BS} = 0$  V and 0.8 V at  $V_{BS} = -1$  V. Find the threshold voltage at  $V_{BS} = -2$  V. (15%)
5. The capacitances of a metal-n-type semiconductor Schottky diode are  $10^{-7}$  F/cm at zero bias and  $5 \times 10^{-8}$  F/cm at 2 V reverse bias. Find the doping of the n-type semiconductor. (10%)
6. Consider a Fabry-Perot laser diode cavity. If  $N$  is the number of half-wavelength that can be accommodated in the cavity, please show that the wavelength separation between two adjacent resonant modes is  $\Delta\lambda = \lambda^2/2L$ , where  $L$  is the length of the cavity. (11%)
7. Please determine the percentage of light that is absorbed in silicon when the sample is illuminated with a light having the energy  $h\nu = 2$  eV. Repeat the same calculation for GaAs. The corresponding absorption coefficients ( $\alpha$ ) of silicon and GaAs are  $4 \times 10^3$  cm<sup>-1</sup> and  $1.5 \times 10^4$  cm<sup>-1</sup>, respectively. Both silicon and GaAs are 0.35  $\mu\text{m}$  thick. (11%)
8. An optical lithographic system is capable of delivering an exposure power of 0.3 mW/cm<sup>2</sup>. The required exposure energies for a positive and a negative photoresists are 140 mJ/cm<sup>2</sup> and 9 mJ/cm<sup>2</sup>, respectively. If we could disregard the times needed for loading and unloading wafers, what would be the wafer throughput (in one hour) for both photoresists? (11%)
9. If a metal line ( $L = 100$   $\mu\text{m}$ ,  $W = 0.18$   $\mu\text{m}$ ) has a sheet resistance of 25  $\Omega/\text{sq}$ , what would be the corresponding resistance of the metal line? (7%)