國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：半導體概論【電機系碩士班甲組】　　題號：431008

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共1頁第1頁

Dielectric constant: Si = 11.9 ; SiO_2 = 3.9

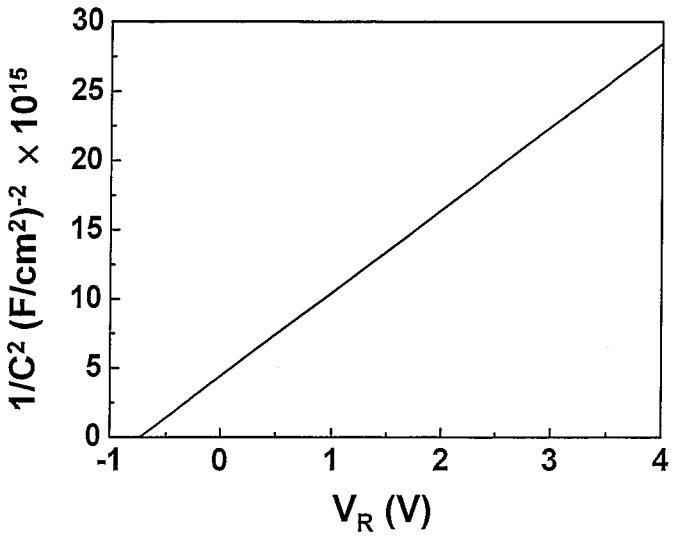
1. An unknown semiconductor has bandgap of 1.36 eV. It is doped with 3×10^{15} cm^{-3} donors. The effective density of states in the conduction band and the valance band are the same. The Fermi level is 0.2 eV below the bottom of the conduction band. Assume that 30% of total electrons are still in the donor states. Find the intrinsic carrier density in the material at $T = 300$ K. (20%)

2. The electron concentration in a semiconductor material is given by

$$n = 5\times10^{16}\left(2-\frac{x}{L}\right) \text{ cm}^{-3} \text{ for } 0 \le x \le L$$

The length of the material L is 100 μm. The electron mobility is 1500 cm^2/V-s at 300 K. An electric field is applied such that the total electron current density is a constant over the given range of x and is $J_n = -95$ A/cm^2. Determine the required electric field versus distance function. (20%)

3. The measured junction capacitance of a p^+-n junction biased at $V_R = 2$ V is 0.15 pF under $T = 300$ K. The intercept of the $1/C^2$ versus V_R curve is –0.735 V. The cross-sectional area is $A = 2\times10^{-5}$ cm^2. Calculate the doping concentrations.



(20%)

4. Consider an n-channel Si MOSFET with $N_A = 3.5\times10^{15}$ cm^{-3} at $T = 300$ K. The oxide is SiO_2 with a thickness of 300 Å. The threshold voltage is found to be $V_T = 0.7$ V when an applied source-to-body voltage $V_{SB} = 2.5$ V. What is the threshold voltage at $V_{SB} = 5$ V ? (20%)

5. A silicon p-n-p transistor has following impurity concentrations.

	emitter	base	collector
N_A or N_D (cm^{-3})	3×10^{18}	2×10^{17}	2×10^{16}

The base width is 1.5 μm and the device cross-sectional area is 0.3 mm^2. When the device is operated in the active mode, the emitter-base junction is forward biased to 0.7 V and the base-collector junction is reverse biased to 6 V. Calculate the neutral base width. (20%)