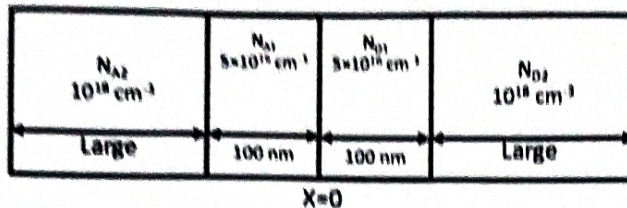


Each question carries 10 marks. Always write appropriate units. Write the final answer to this sheet and tie with your answer sheet.

$D_p$	$5 \text{ cm}^2/\text{s}$	$E_g$	$1.1 \text{ eV}$	$E_{\text{semi}}$	11.8	$\epsilon_0$	$8.85 \times 10^{-14} \text{ F/cm}$
$D_n$	$10 \text{ cm}^2/\text{s}$	$T$	300 K	$L_n$	$100 \mu\text{m}$	$L_p$	$50 \mu\text{m}$
$n_i$	$1.1 \times 10^{10} \text{ cm}^{-3}$	$m_h^*/m_i^*$	1.06	$E_{\text{ox}}$	3.9		

1. Consider the p-n junction diode shown below:



Find out the electric field in V/cm at  $x=0$ .

Ans:

2. Consider a piece of a semiconductor with  $N_A=10^{11} \text{ cm}^{-3}$  and  $N_D=9 \times 10^{10} \text{ cm}^{-3}$ . Find out the number of a) holes (p), b) electrons (n) and c) position of the Fermi level with respect to the intrinsic Fermi energy (in eV) of the semiconductor? [3+3+4]

Ans: a)

b)

c)

3. The HFCV and LFCV in a n-MOSFET at a gate voltage +1 V above threshold are given by  $0.4 \mu\text{F}/\text{cm}^2$  and  $0.04 \mu\text{F}/\text{cm}^2$ , respectively. What is the doping concentration of the substrate?

Ans:

4. Consider a n-MOSFET with substrate doping concentration  $N_A=10^{16} \text{ cm}^{-2}$  and  $t_{\text{ox}}=4 \text{ nm}$ . Assuming  $\phi_{\text{ms}}=0$  and  $V_{\text{DS}}=0$ , find out the a) voltage across the oxide at a gate voltage of +1 V and b) surface potential. [5+5]

Ans: a)

b)

5. Consider a n-MOSFET with a substrate doping concentration of  $N_A=10^{16}$  and gate length of  $L=1 \mu\text{m}$ . The  $0.5 \mu\text{m}$  half of the gate towards source has an oxide thickness of 4 nm and the rest  $0.5 \mu\text{m}$  towards the drain has an oxide thickness of 2 nm. Assuming  $\phi_{\text{ms}}=0$ , find out the drain-to-source current (in mA) for a)  $V_{\text{DS}}=10 \text{ mV}$  and  $V_{\text{GS}}=0.5 \text{ V}$  and b)  $V_{\text{DS}}=10 \text{ mV}$  and  $V_{\text{GS}}=2 \text{ V}$ . [5+5]

Ans: a)

b)

6. Consider a diode where the width of the p and n regions are much smaller than the minority carrier diffusion length in the respective regions. Find out the expression for the in terms of other parameters.

Ans:

7. Consider a bipolar junction transistor with Emitter- $N_{\text{DE}}=2 \times 10^{18} \text{ cm}^{-3}$ , Base- $N_{\text{AB}}=2 \times 10^{16} \text{ cm}^{-3}$ , and collector  $N_{\text{DC}}=10^{15} \text{ cm}^{-3}$  with  $W_{\text{E}}=0.2 \mu\text{m}$  and  $W_{\text{B}}=0.1 \mu\text{m}$ . Find out a)  $\alpha$  of the transistor during regular operation (forward active mode). If a user swaps the connection by mistake between Emitter and Collector during circuit operation (reverse active mode) find out the b) modified  $\alpha$  of the transistor. [5+5]

Ans: a)

b)