Indian Institute of Technology Dharwad

Electronic Devices (EE 229)

End-Sem Examination

Open Book 21/09/2021

Max Marks: 25 Max Duration: 2 hours

Instructions: (1) Scribbled/ overwritten answers will not be evaluated.

(2) Writing answers without proper units would result into deduction of marks.

(3) Enclose the final answer in a box. Write down the assumptions, if any, clearly

(4) Answer all the sub-parts of a question together.

(5) ***Collaborations among the classmates is strictly prohibited***

Q.1 A thin film resistor is to be made from a GaAs film doped with donor type dopants. The resistor is to have a value of 2 kΩ. The resistor length is to be 200 μm and area is 10^{-6} cm^2. The mobility of electrons is 8000 cm^2/V-s. What should be dopant concentration introduced into the semiconductor if the doping efficiency is 90% (i.e. only 90% of the total dopants ionize). ***(2 marks)***

Q.2 A Germanium device is doped with a donor concentration of 3 X 10^{15}/cm^3. For the device to operate properly, the intrinsic carrier concentration must remain less than 5% of the total concentration. Find out the maximum temperature on which the device may operate if the bandgap of Germanium is 0.66 eV and the intrinsic carrier concentration at 300 K is 2.43 X 10^{13}/cm^3. ***(3 marks)***

Q. 3 The electric field distribution of a silicon *p-n* junction is as shown in Figure 1. The temperature at which the device is operating is unknown. Find (a) built-in potential (b) ratio of the doping concentration of *p* and *n* regions (c) the doping concentrations of *p* and *n* regions if ε_{si} = 11.8. ***(5 marks)***

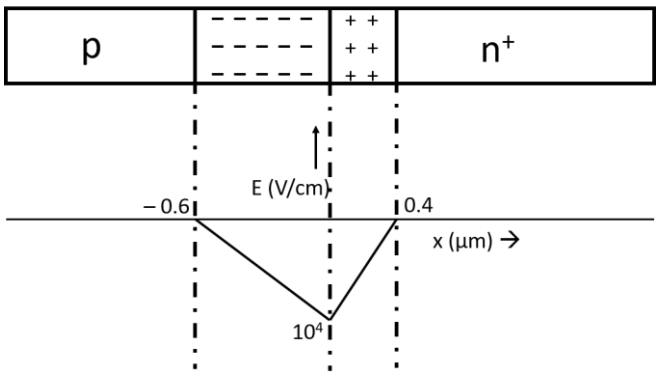
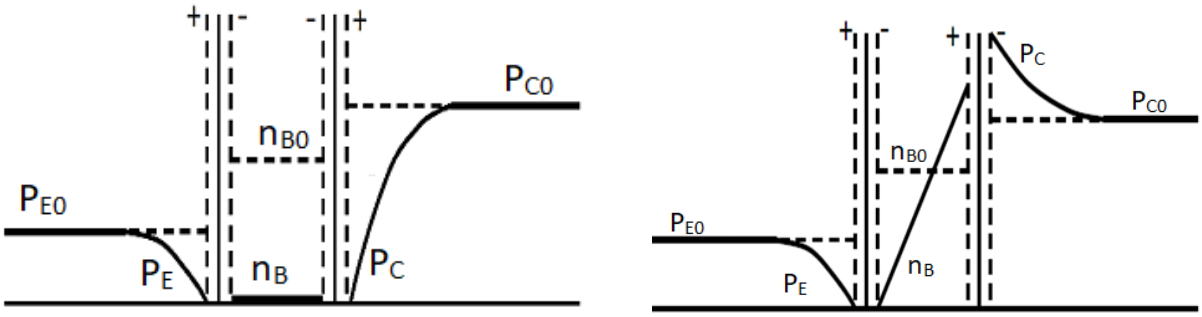


Figure 1

Q. 4 Identify the mode of operation of the BJTs by looking at the charge profiles of emitter, base and collector regions respectively as shown in Figure 2. Also, identify the type of BJT (npn or pnp) ***(2 marks)***



(a) (b)

Figure 2

Q. 5 Consider the given C-V characteristics of a Si-MOSFET as shown in Figure 3

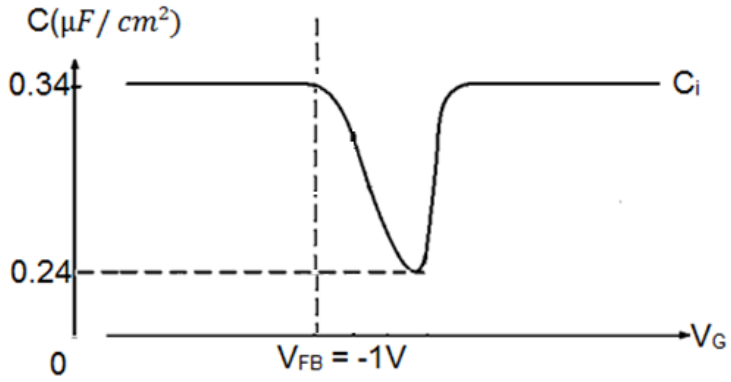


Figure 3

If the substrate doping concentration is 1.5 X $10^{17}/cm^3$, then find out the following:

(a) Thickness of the oxide layer
(b) Maximum width of the depletion layer
(c) Find the doping concentration of the substrate, if it is given that flatband voltage is constituted only by Φ_{MS}, the metal work function is equal to 3.8 V and the electron affinity of the semiconductor is equal to 4.05 eV. ***(5 marks)***

Q. 6 If the emitter current of a BJT at room temperature doubles, what should be effect on the base-emitter junction voltage? Assume that the applied base-emitter voltage is sufficiently higher than the thermal voltage for both the cases. ***(2 marks)***

Q. 7 Find the reverse current of a pn junction diode, if a current of 50 mA is observed across it for a forward voltage of 0.7 V. ***(2 marks)***

Q. 8 An ideal n-channel MOSFET has the following parameters: Z=30 μm, L=2 μm, oxide thickness=35 nm, threshold voltage is 0.8 V, ε_{SiO2} = 3.9, and surface mobility of electrons is 450 cm^2/V-s. If it is MOSFET is in saturation, find the drain current for an applied gate voltage of 4 V. Also, find the transconductance of the MOSFET. ***(4 marks)***