21 Nov 2022

EE101 Tutorial 1

Topics: Semiconductors and Diodes

Q1. The intrinsic carrier concentration of germanium (GE) is expressed as

ni = 1:66 _ 1015T3=2 exp □Eg
2kT
$Ni=1.666 \times 10^{15} T^{3/2} \exp\frac{-Eg}{2KT} cm^{-3}$
where Eg=0.66 eV
(a) Calculate ni at 300 K and 600 K and compare the results with those obtained in Example 2.1 for Si.
(b) Determine the electron and hole concentrations if Ge is doped with P at a density of $5\times10^{16}\,cm^{-3}$

Q2. A junction employs $N_D = 5 \times 10^{17}\ cm^{-3}$ and $N_A = 4 \times 10^{16}\ cm^{-3}$.
(a) Determine the majority and minority carrier concentrations on both sides.
(b) Calculate the built-in potential at 250 K, 300 K, and 350 K. Explain the trend.

Q3. An oscillator application requires a variable capacitance with the characteristic shown in Fig. 1. Determine the required N_D if $N_A = 10^{17}$ /cm^{-2}

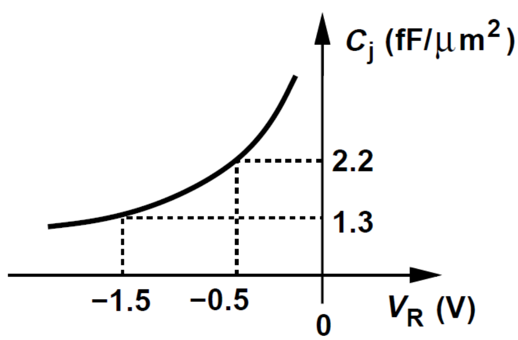


Fig. 1

Q4. We have received the circuit shown in Fig. 2 and wish to determine R_1 and I_S. We note that V_X= 1 V I_X= 0.2 mA and V_X=2 with Ix= 0.5 mA. Calculate R_1 and I_S = 1 V

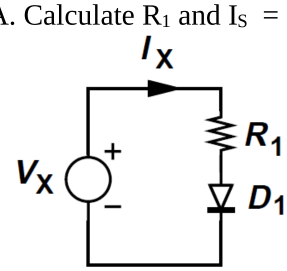


Fig. 2

Q5. Plot I_X as a function of V_X for the circuit shown in Fig. 3 for two cases: V_B = -1 V and V_B= +1 V.

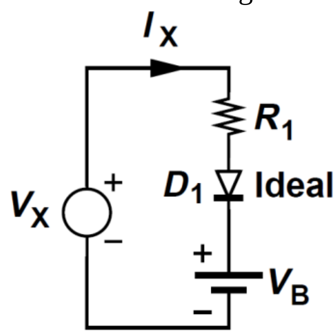
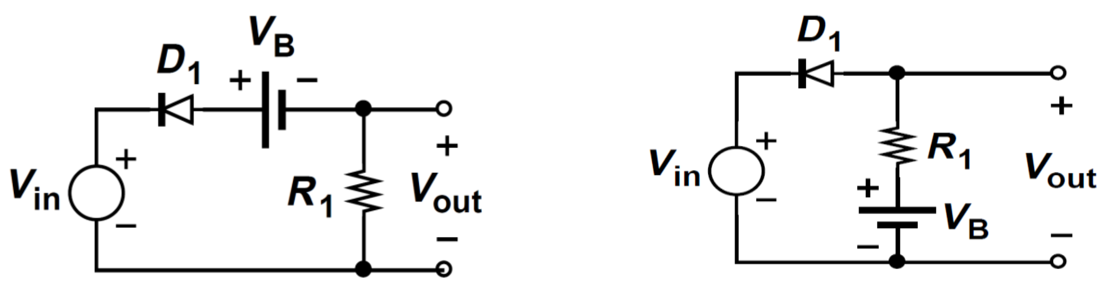


Fig. 3

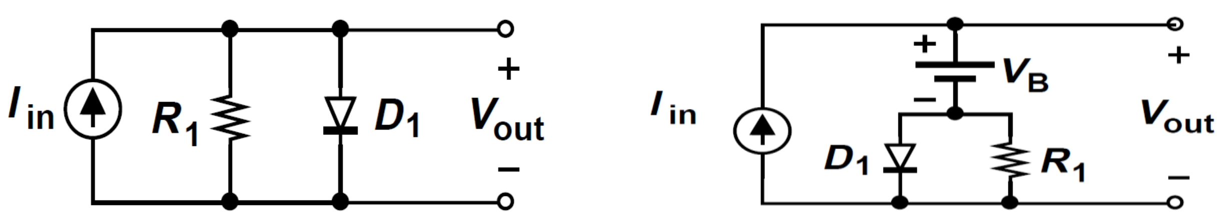
Q6. Plot the input/output characteristics of the circuits depicted in Fig. 4 using an ideal model for the diodes. Assume V_B = 2 V.



(a) (b)

Fig. 4

Q7. Assuming a constant-voltage diode model, plot V_{out} as a function of I_{in} for the circuits shown in Fig. 5.



(a) (b)

Fig. 5

Q8. Plot the input/output characteristics of the circuits illustrated in Fig. 6. Assuming a constant-voltage diode model and V_B=2 V.

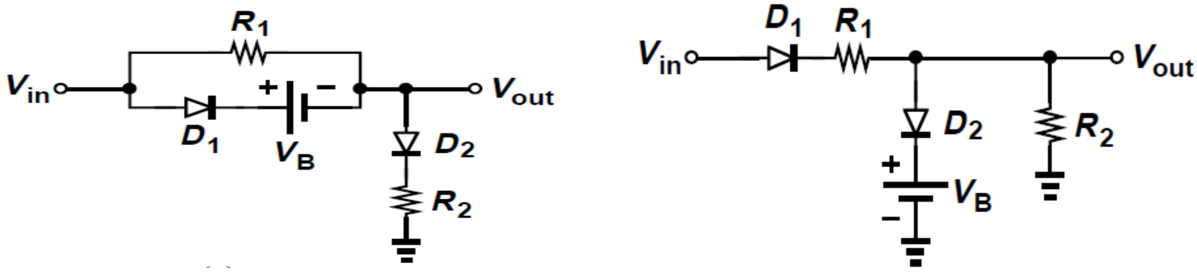


Fig. 6

Q9. We wish to design a circuit that exhibits the input/output characteristic shown in Fig. 7. Using 1-k ohm resistors, ideal diodes, and other components, construct the circuit.

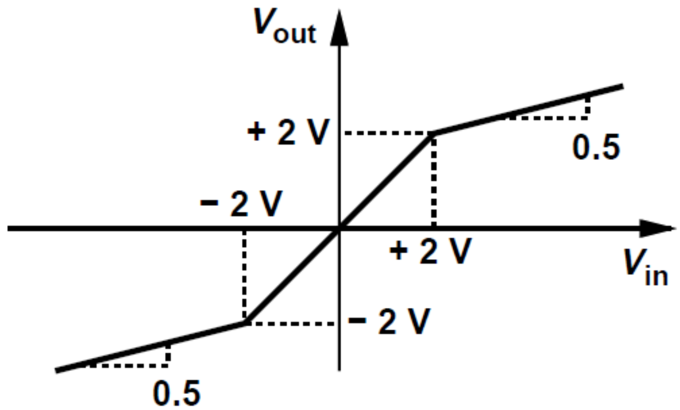


Fig. 4