



EECS 105 – Microelectronic Devices and Circuits

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Dept. EECS,

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Course Web Site <http://www-inst.EECS.Berkeley.EDU/~ee105/>

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Homework Assignment # 8, Due March 16, 2001

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8.1 The pn Junction Diode

Device dimensions and physical parameters of a pn junction diode are listed below.

Dimensions:	Doping:	Diffusion coefficients:
$W_p=0.5\mu\text{m}$	$N_a=5\times 10^{17}\text{cm}^{-3}$	$D_n=5\text{cm}^2/\text{s}$
$W_n=1.0\mu\text{m}$	$N_d=2\times 10^{16}\text{cm}^{-3}$	$D_p=5\text{cm}^2/\text{s}$

The pn junction has an area of $A=20\mu\text{m}\times 20\mu\text{m}$. For a forward bias of 0.7V,

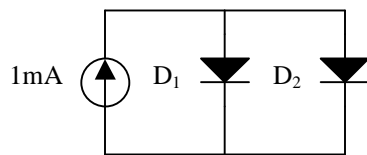
- Find the diode saturation current I_0 .
- Find the diode current I_D .
- Find the small-signal resistance r_d .
- Find the depletion capacitance C_j .
- Find the diffusion capacitance C_d .
- Draw the small-signal model.

SEE CORRECTION

You can assume $x_n\ll W_n$ and $x_p\ll W_p$.

8.2 Diodes in Circuits

Two diodes D_1 and D_2 are connected in parallel with a total of 1mA current. If D_1 has $N_a=10^{18}\text{cm}^{-3}$, $N_d=10^{15}\text{cm}^{-3}$ and D_2 has $N_a=10^{17}\text{cm}^{-3}$, $N_d=10^{15}\text{cm}^{-3}$, find the current flow through each diode. **Assume that W_p and W_n are 2.0 mm.** (Hint: neglect the electron minority current and compare the built-in voltage.)



8.3 The Bipolar Junction Transistor

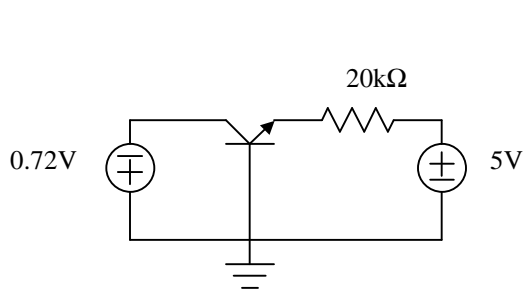
Device dimensions and physical parameters of a npn bipolar transistor are listed below.

Dimensions:	Doping:	Diffusion coefficients:
$W_B=0.5\mu\text{m}$	$N_{aB}=10^{17}\text{cm}^{-3}$	$D_{nB}=5\text{cm}^2/\text{s}$
$W_E=1.0\mu\text{m}$	$N_{dE}=8\times 10^{18}\text{cm}^{-3}$	$D_{pE}=5\text{cm}^2/\text{s}$

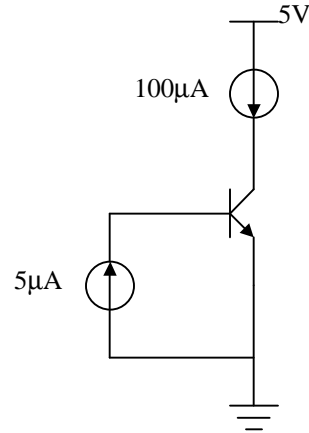
- Sketch the minority carrier distribution under forward-active bias.
- Find α_F .
- Find forward-active current gain β_F .

8.4 BJT Operating Regions

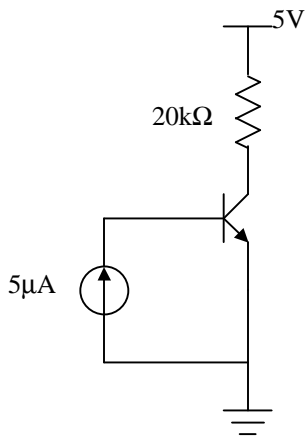
Identify the operating region (cutoff, forward active, saturation, or reverse active) of the following npn bipolar junction transistors: (npn: $\beta_F=100$)



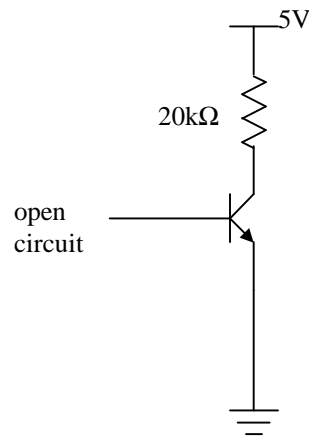
(a)



(b)



(c)



(d)