

Name:

Question 1:

An abrupt Si BJT has the following properties at 300K:

Emitter	Base	Collector
$N_d=10^{19}\text{cm}^{-3}$	$N_a=10^{17}\text{cm}^{-3}$	$N_d=10^{15}\text{cm}^{-3}$
$\tau_p=.1\times 10^{-6}\text{s}$	$\tau_n=1\times 10^{-6}\text{s}$	$\tau_p=.1\times 10^{-6}\text{s}$
$A=10^{-4}\text{cm}^2$	$A=10^{-4}\text{cm}^2$	$A=10^{-4}\text{cm}^2$
$L_E=10\times 10^{-4}\text{cm}$	$L_B=10\times 10^{-4}\text{cm}$	$L_C=300\times 10^{-4}\text{cm}$

a) Draw the energy band diagram for the both junctions at TE.

Show

V_o for both junctions, x_n and x_p for both junctions, Fermi levels, and W_b .

b) Draw the energy band diagram for the emitter base junction under .65 volts forward bias, and the CB junction under -5 volts reverse bias. Show V_o for both junctions, x_n and x_p for both junctions, Fermi levels, and W_b .

c) Draw the energy band diagram for the emitter base junction under -5 volts reverse bias, and the CB junction under .65 volts forward bias. Show V_o for both junctions, x_n and x_p for both junctions, Fermi levels, and W_b .

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Question 2:

a) For the BJT in question1 calculate emitter injection efficiency (γ), base transport factor (B), and common emitter current gain (β), under forward active and reverse active biasing.

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Question 3:

An Si BJT has the following properties at 300K:

Emitter	Base	Collector
$N_d=10^{19}\text{cm}^{-4}$	$N_a=10^{17}\text{cm}^{-3}$	$N_d=10^{19}\text{cm}^{-3}$
$\tau_p=.10\times 10^{-6}\text{s}$	$\tau_n=1\times 10^{-6}\text{s}$	$\tau_p=.1\times 10^{-6}\text{s}$
$A=10^{-4}\text{cm}^2$	$A=10^{-4}\text{cm}^2$	$A=10^{-4}\text{cm}^2$
$L_E=10\times 10^{-4}\text{cm}$	$L_B=10\times 10^{-4}\text{cm}$	$L_C=300\times 10^{-4}\text{cm}$

- Using an excel like program, calculate W_b for the above diode with $V_{BE}=.7\text{Volts}$ for $V_{CB}=-.5,-1,-1.5,-2,-2.5,$ and -10 volts.
- Calculate β for the above conditions.
- At what V_{CB} will W_b go to zero?
- Which is smaller the voltage you found in part c, or the breakdown voltage of the junction?

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Question 5:

For the diode of question 1($V_{be}=.65V$, $V_{cb}=-5V$), estimate f_T . Assume that electrons travel through the depletion region at the saturation velocity.

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Question 6:

For an npn BJT, How do you scale W_b to keep the same common emitter current gain (β) if you decrease τ_n by a factor of 10?

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Question 7:

List and explain some methods of improving the high frequency performance of BJTs. Include the engineering tradeoffs you have to make.