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Student ID:

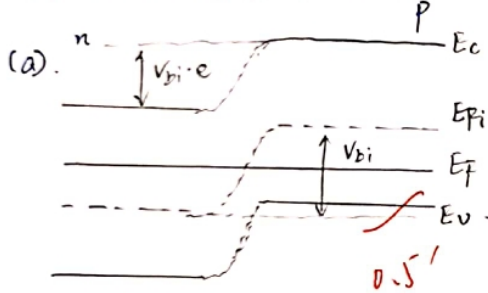
1. What are the two breakdown mechanisms in reverse-biased pn junction? Please explain them using your own words. 1.5'

~~Zener~~ Zener breakdown: in highly doped pn junction, the valence band and conduction bands ^{on opposite sides} are too close, that the electron can directly "tunnel" from valence band on p-side to conduction band on n-side.

Avalanche breakdown: Electrons and holes acquire enough energy, that they can collide with atomic electrons in the depletion region, creating new electron-hole pairs. And these newly-created electrons and holes also acquire enough energy, and continue collision, which is like "avalanche", creating more and more electrons and holes.

2. A silicon pn junction at $T = 300$ K has doping concentrations of $N_a = 2 \times 10^{16} \text{ cm}^{-3}$ and $N_d = 5 \times 10^{15} \text{ cm}^{-3}$. Draw the band diagram of the pn junction, when the junction has (a) zero bias, (b) reverse bias at 2V, (c) forward bias at 3V, please label the necessary values on the plot clearly.

(d) Determine x_n , x_p , W , and $|E_{\max}|$.



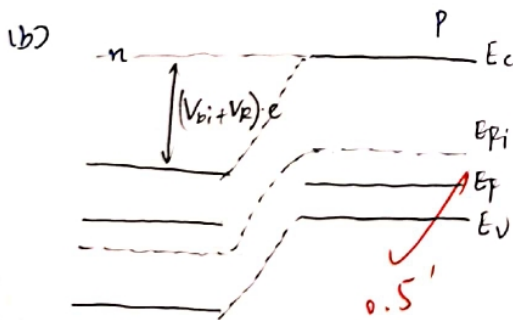
$$V_{bi} = 0.69773 \text{ V}$$

$$x_n = 3.8 \times 10^{-5} \text{ cm. } 0.5'$$

$$x_p = 9.5 \times 10^{-6} \text{ cm. } 0.5'$$

$$W = x_n + x_p = 4.75 \times 10^{-5} \text{ cm. } 0.5'$$

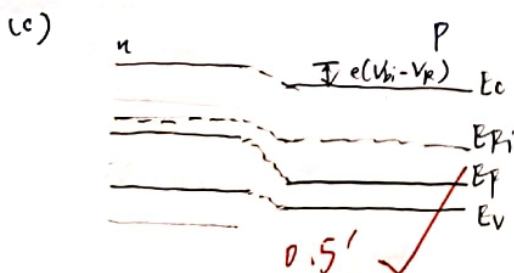
$$|E_{\max}| = 29360 \text{ V/cm } 0.5'$$



$$V_{bi} = 0.69773 \text{ V}$$

$$x_n = 7.47 \times 10^{-5} \text{ cm}$$

$$x_p =$$



$$V_{bi} = 0.69773 \text{ V}$$

$$x_n = 6.9 \times 10^{-5} \text{ cm.}$$

