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Questions to be Challenged in

GATE 2020

Electronics and Communication Engineering

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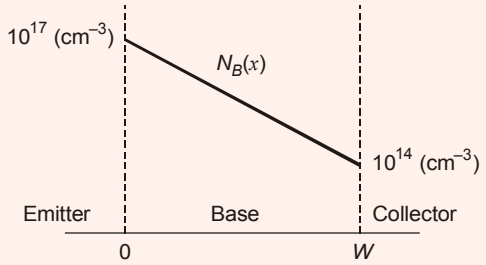
Q.38 The base of an npn BJT T1 has a linear doping profile $N_B(x)$ as shown below. The base of another npn BJT T2 has a uniform doping N_B of 10^{17} cm^{-3}. All other parameters are identical for both the devices. Assuming that the hole density profile is the same as that of doping, the common-emitter current gain of T2 is



(a) approximately 0.3 times that of T1 (b) approximately 0.7 times that of T1
(c) approximately 2.5 times that of T1 (d) approximately 2.0 times that of T1

Ans. (*)

$$\frac{\beta_1}{\beta_2} = \frac{\int_0^W N_{A_2}(x)dx}{\int_0^W N_{A_1}(x)dx} = \frac{W\times 10^{17}}{\frac{1}{2}\times W\times(10^{17}-10^{14})} = \frac{2\times 10^{17}}{10^{17}+10^{14}} \simeq 2$$

$$\beta_2 = 0.5\beta_1$$

Hence no option is matching.

GATE Ans. Key (d)

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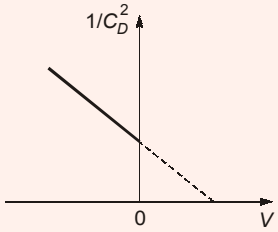
Q.46 A one-sided abrupt pn junction diode has a depletion capacitance C_D of 50 pF at a reverse bias of 0.2 V. The plot of $1/C_D^2$ versus the applied voltage V for this diode is a straight line as shown in the figure below. The slope of the plot is ____ $\times 10^{20}$ F^{-2} V^{-1}.



(a) –1.2
(b) –5.7
(c) –3.8
(d) –0.4

Ans. (*)

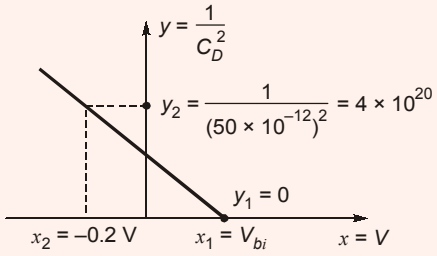
Depletion or transition capacitance is,

$$C_D = \frac{A\epsilon}{W}$$

For one-sided PN junction (Ex : P^+ N junction)

$$W = \sqrt{\frac{2\epsilon V_B}{eN_D}} = \sqrt{\frac{2\epsilon (V_{bi} - V)}{eN_D}}$$

where V is anode to cathode applied potential.



$$\Rightarrow \quad C_D = \frac{A\epsilon}{\sqrt{\frac{2\epsilon (V_{bi} - V)}{eN_D}}}$$

$$\Rightarrow \quad \frac{1}{C_D^2} = \frac{2}{A^2 \epsilon \, eN_D}(V_{bi} - V)$$

$\frac{1}{C_D^2}$ becomes zero at $V = V_{bi}$

From above graph, $y = \frac{1}{C_D^2} = 0$ at $x_1 = V_{bi}$

And $\quad y_2 = \frac{1}{C_D^2} = 4 \times 10^{20}$ at $x_2 = -0.2$ V

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4 \times 10^{20} - 0}{-0.2 - V_{bi}}$$

$\because$ V_{bi} is not provided, slope cannot be found.

GATE Ans. Key (d)

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