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Student ID:

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EHB222E Introduction to Electronics
MIDTERM I

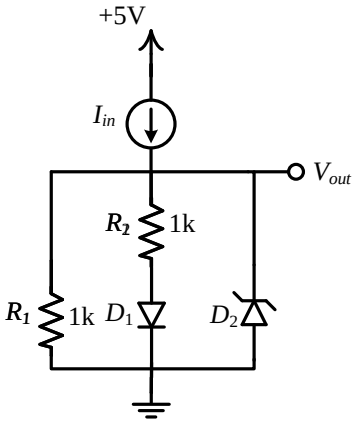
Duration: 120 Minutes
Grading: 1) 15%, 2) 30%, 3) 25%, 4) 30%
Exam is in closed-notes and closed-books format; calculators are allowed
For your answers please use the space provided in the exam sheet
GOOD LUCK!

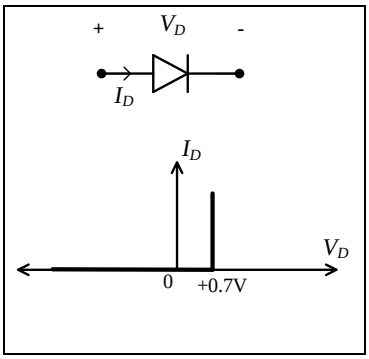
1. The current-voltage equation of a p-n diode is given as $I_D = I_S\left(e^{V_D/nV_T} - 1\right)$ where $I_S = Aqn_i^2\left(\frac{D_p}{L_pN_D} + \frac{D_n}{L_nN_A}\right)$. Additionally, $L_p = \sqrt{D_p\tau_p}$ and $L_n = \sqrt{D_n\tau_n}$. The diode conducts current of -10^{-15}A when -3V voltage applied. Determine the **junction area *A***. with a unit of **μm^2**.

Parameters: $n_i = 2{,}5\ 10^{10}$ /cm^3, $N_D = 10^{17}$ /cm^3, $N_A = 10^{15}$ /cm^3, q = $1{,}6\ 10^{-19}$C, $1 \leq n \leq 2$, $V_T = 25$ mV, $D_n = 100$ cm^2/s, $D_p = 16$ cm^2/s, $\tau_n = \tau_p = 1$ μsec.

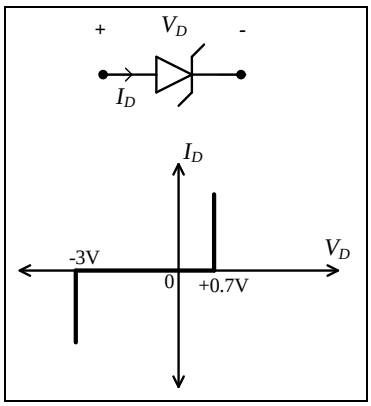
2. For the diodes, use the models shown below; the regular diode model has **0,7V** forward bias voltage; the Zener diode model has **-3V** breakdown voltage.

a. Determine the minimum positive value of $\boldsymbol{I_{in}}$ to make D_1 conduct current.
b. Determine the minimum positive value of $\boldsymbol{I_{in}}$ to make D_2 conduct current.
c. Sketch $\boldsymbol{V_{out}}$ **versus** $\boldsymbol{I_{in}}$ $(0 \le I_{in} \le 10\text{mA})$.



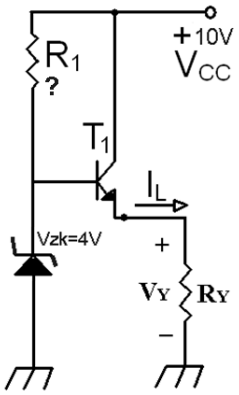


Regular Diode Model

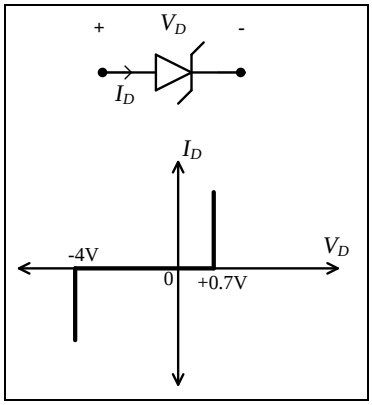


Zener Diode Model

3. Consider a voltage source shown below. It drives a load with a minimum value of 100Ω; $R_Y \geq 100\Omega$. Its output voltage should be around 3.3V; $V_Y \approx 3.3V$. Determine the maximum value of $\mathbf{R_1}$.



Voltage Source



Zener Diode Model, Vzk=4V

Transistor parameters: $V_{BE} = 0.7$, $\beta = 100$, $V_A = \infty$.

4. For the circuit shown below, suppose that all of the transistors are in forward active region; $|V_{BE}|$= 0.7V, β = 200, and $|V_A|=\infty$ for all transistors.

a. If Vi=0V, determine the values of $\boldsymbol{I_{C_1}}$, $\boldsymbol{I_{C_2}}$, and $\boldsymbol{I_{C_3}}$.

b. If Vi=0V and I_{C_4}=0,5mA, determine the value of $\mathbf{R_{E4}}$.