Solution sketch

National Taiwan Normal University
Department of Computer Science and Information Engineering

CSU0007 - Basic Electronics

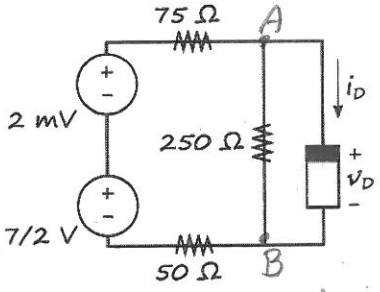
Homework 3

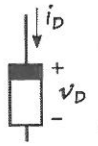
100 points total. Due on 9AM, Monday, 5/11/2020.
Submit your answer via Moodle. Clearly state your analysis to earn full score.

1 (40 points) Answer the following two questions:

1.1 (20 points) In the midterm exam, the corrected answer of Question 5c shows that v_O=1.75V, not 2V. Why does the voltage across the diode become smaller than 2V? State your qualitative opinion.

1.2 (20 points) For the following circuit, apply the small-signal analysis to find current i_D. Recall that you may apply Thévenin's theory to help simply the analysis.

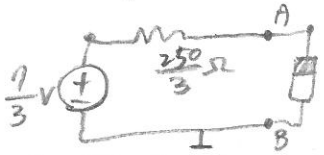




$i_D = \begin{cases} K \cdot v_D^2 & \text{for } v_D > 0 \\ 0 & \text{otherwise} \end{cases}$
Assuming $K = 1\ mA/V^2$

(1.1) In general, 並聯後的等效電阻值會下降, and thus voltage divider 分到的電壓會較低.

(1.2) Using Thévenin's theory, we see the following is an equalvence: (with respect to the 7.2 V signal)



and by analysis we know $V_D > 0$

Now, by KCL + element law:

$\frac{\frac{7}{3} - V_D}{\frac{250}{3}} = i_D = K \cdot V_D^2$

$\Rightarrow V_D = 2V$

$\Rightarrow i_{D_1} = 4\ mA$

Now, by small signal analysis

$r_d = \frac{1}{2K v_D|_{v_D=2}}$

$= 250\ \Omega$

$\Rightarrow i_{D_2} = \frac{2\ mV \times \frac{250 \| 250}{75+50+250\|250}}{250}$

$= 4\ \mu A$

$\Rightarrow i_D = i_{D_1} + i_{D_2} = 4.004\ mA$ *

2 (60 points) Answer the following two questions regarding the mapping between voltage levels and logic values in the static discipline, given thresholds V_{IL}=1.8V, V_{IH}=2.3V, V_{OL}=1V, and V_{OH}=4V, and assume the highest voltage level is 5V:

2.1 (30 points) Suppose a sender sent a logic 0 by placing V_{OUT}=0.9V, and the noise during transmission added 0.7V to the signal. Would its receiver be able to correctly interpret the signal as a logic 0? Give a quantitative reason.

2.2 (30 points) For the electronic system working under the given static discipline, can the following electronic device work correctly with the system? The device produces voltage level V_{OUT}=0.8V for sending a logic 0 and V_{OUT}=4.5V for sending a logic 1. The device will interpret all input signals between 0V and 2V as a logic 0 and all input signals between 2.5V and 5V as a logic 1. Show your quantitative analysis.

(2.1) Yes. $0.9 + 0.7 = 1.6 < V_{IL}$.

(2.2) No.
✓(1) $0.8V < V_{OL}$
✓(2) $4.5V > V_{OH}$
✓(3) $0V \sim 2V$ as a logic 0 ⇒ it can interpret V_{IL} and below as a logic 0.
✗(4) $2.5V \sim 5V$ as a logic 1 ⇒ it might not interpret $2.3V \sim 2.5V$ as a logic 1.