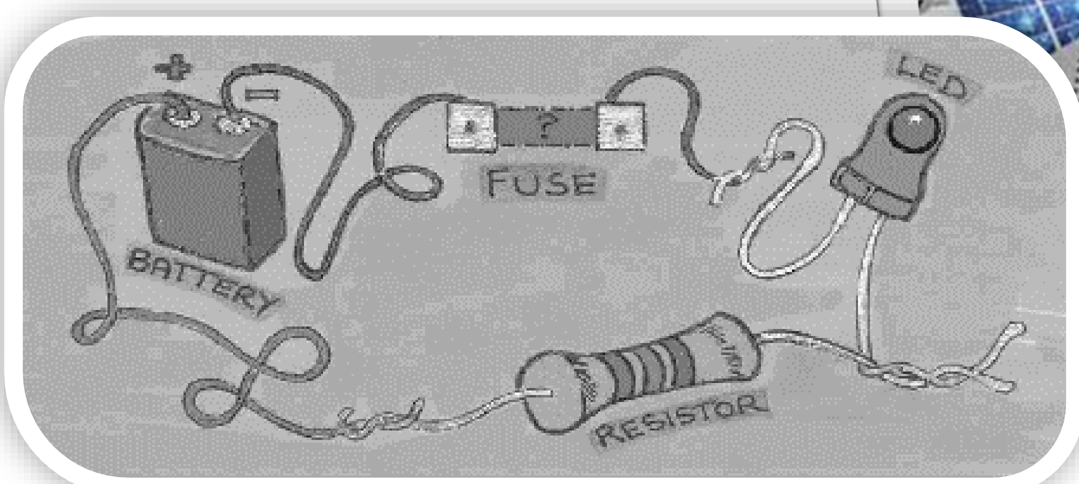
EHB222E QUESTIONS
4th week



A p-n diode is modeled with the exponential model. The diode currents are measured 1.36 mA and 7.20 mA when 0.7 V and 0.75 V applied, respectively. Determine the saturation current I_S and the emission factor n (from nV_T). Suppose that V_T = 25 mV.

($V_T = 25$ mV alınız)

Çözüm: $I_D = I_S\left(e^{\frac{V_D}{nV_T}} - 1\right)$ olmak üzere iletim durumunda $e^{\frac{V_D}{nT}} \gg 1$ kabul edersek $I_D \cong I_S \cdot e^{\frac{V_D}{nV_T}}$ olur. Buna göre;

$$\left.\begin{aligned} I_{D1} &= I_S \cdot e^{\frac{V_{D1}}{nV_T}} \\ I_{D2} &= I_S \cdot e^{\frac{V_{D2}}{nV_T}} \end{aligned}\right\} \quad \frac{I_{D2}}{I_{D1}} = e^{\frac{V_{D2}-V_{D1}}{nV_T}} \Rightarrow \ln\left(\frac{I_{D2}}{I_{D1}}\right) = \frac{V_{D2}-V_{D1}}{nV_T}$$

$$\Rightarrow nV_T = \frac{V_{D2}-V_{D1}}{\ln\left(\frac{I_{D2}}{I_{D1}}\right)} \Rightarrow n = \frac{V_{D2}-V_{D1}}{V_T \cdot \ln\left(I_{D2}/I_{D1}\right)} = \frac{0.75-0.7}{25\times10^{-3}\times\ln\left(7.20/1.36\right)}$$

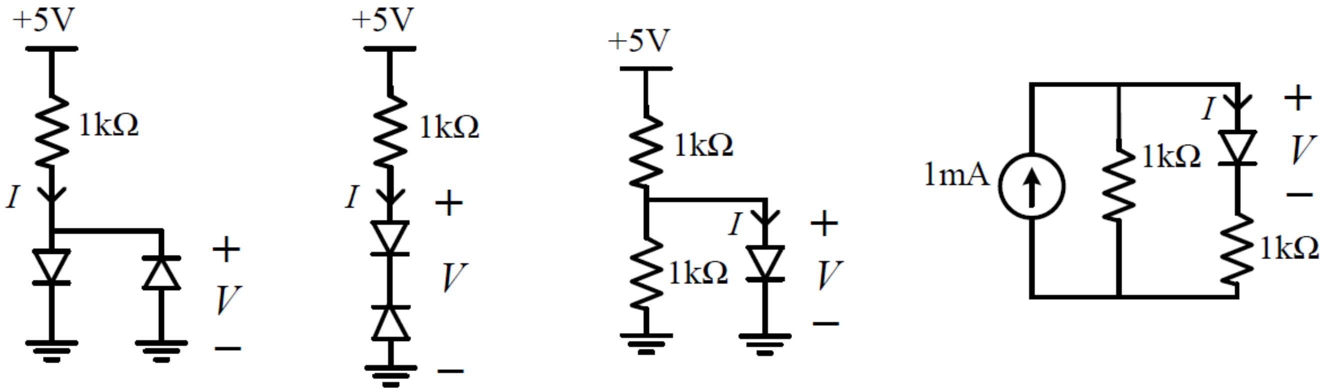
$= 1.2$ olarak bulunur.

$$I_S = \frac{I_D}{e^{\frac{V_D}{nV_T}} - 1} = \frac{7.2\text{ mA}}{e^{\frac{0.75\text{V}}{1.2\times25\text{mV}}} - 1} \cong 10^{-13}\text{ A}$$ olarak bulunur

↳ yine ihmâl edilebilir **!**

İhmâli yaptıktan sonra geri dönüp bulunan sonuç ile tutarlı bir ihmâl mi kontrol etmek gerekir **!**

Find the values of I and V for the circuits shown. Use ideal diode model (V_d=0) for diodes.



Ans. (a) 5 mA, 0V; (b) 0 mA, 5V; (c) 5 mA, 0V;
(d) 0.5 mA, 0V;

Use a modified ideal model for the Zener diode in Figure 1. The model has 0,7 V forward bias and 2V Zener (V_Z=2V) voltage. An input signal, shown in Figure 2, is applied. Sketch V_o, i_{D1} and i_{D2} in time domain. Justify your answer.

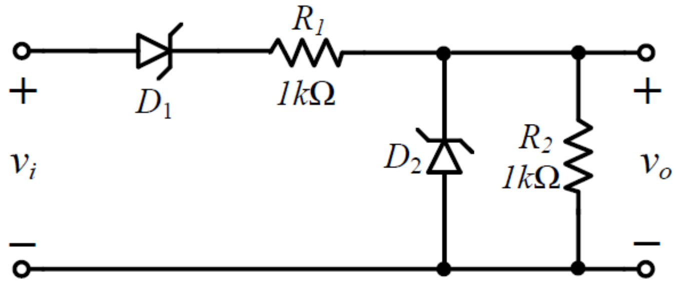


Figure 1

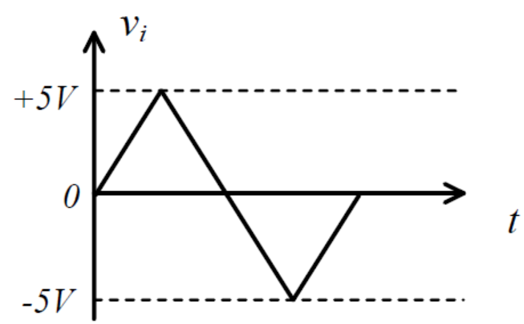
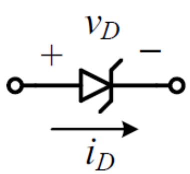
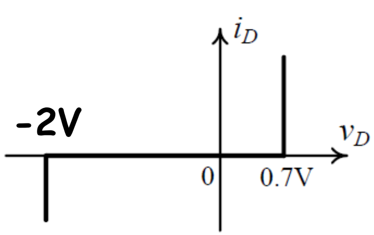
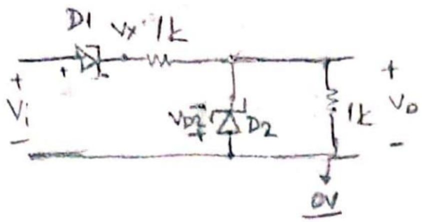


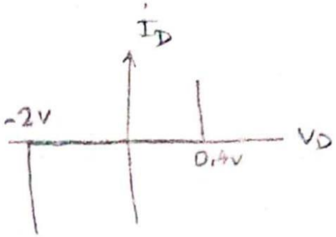
Figure 2





(3-)





(1) $V_{D1} = -2V$ (2) $-2V < V_{D1} < 0,7V$ (3) $V_D = 0,7V$

(1-)

$V_{D1} = -2V$ $I_{D1} < 0$

a) $I_{D2} > 0$

$V_{D2} = 0,7V$

$V_o = 0 - V_{D2} = -0,7V$

$$\frac{0 - V_o}{1k} < \frac{V_o - V_x}{1k}$$

$$\frac{0,7V}{1k} < \frac{-0,7 - (V_i + 2V)}{1k}$$

$V_i + 2V < -1,4V$

$V_i < -3,4V$

b) $I_{D2} = 0$

$V_{D2} < 0,7V$

$V_o > -0,7V$

$$\frac{0 - V_o}{1k} = \frac{V_o - (V_i + 2V)}{1k}$$

$2V_o = V_i + 2V$

$$\boxed{V_o = \frac{V_i + 2V}{2}} = \frac{V_i}{2} + 1V$$

$$\frac{V_i + 2V}{2} > -0,7V$$

$V_i > -3,4V$

(2)

$\boxed{V_o = 0V}$

$V_i - V_D = 0$

$V_i = V_D$

$\boxed{-2V < V_i < 0,7V}$

2

(3.) $V_D = 0{,}7V$ $\quad v_x = V_i - 0{,}7\,V$

$I_{D1} > 0$

a) $V_{D2} > -2V$ $\quad I_{D2} = 0$

$V_o < 2V$

$$\frac{V_i - 0{,}7V - V_o}{1k} = \frac{V_o}{1k}$$

$$V_i - 0{,}7V = 2V_o$$

$$\boxed{\frac{V_i - 0{,}7V}{2} = V_o}$$

$$\frac{V_i - 0{,}7V}{2} < 2V$$

$$\boxed{V_i < 4{,}7V}$$

b) $V_{D2} = -2V$

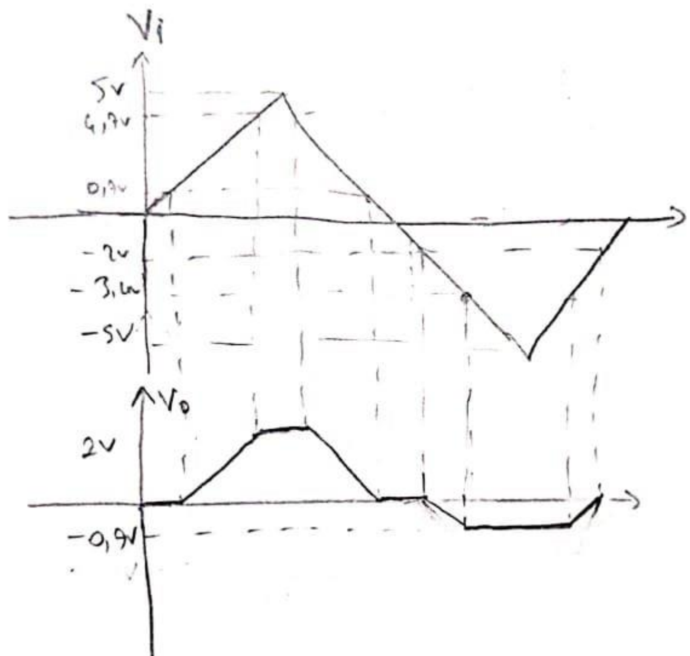
$V_o = 2V$

$$\frac{V_i - 0{,}7V - V_o}{1k} > \frac{V_o}{1k}$$

$$\frac{V_i - 0{,}7V}{2} > V_o$$

$$V_i - 0{,}7V > 4$$

$$\boxed{V_i > 4{,}7V}$$



$-5V < V_i < -3{,}4V$

$-3{,}4V < V_i < -2V$

$-2V < V_i < 0{,}7V$

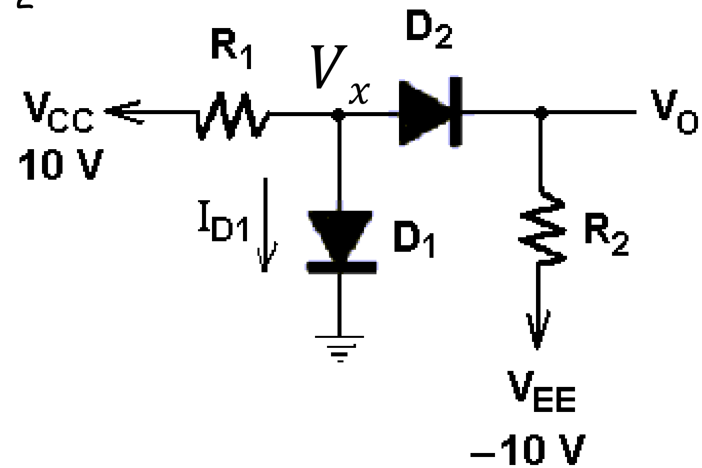
$0{,}7V < V_i < 4{,}7V$

$4{,}7V < V_i < 5V$

In figure, assume modified diode model (V_D=0.7V) for the diodes.

a) Calculate I_{D1} and V_O for R_1=10 kΩ, R_2=5 kΩ.

b) Calculate I_{D1} and V_O for R_1=5 kΩ, R_2=10 kΩ.



<u>***D1 ON, D2 OFF***</u>

(b) V_{D2}= V_{D1}-V_{EE}= 10.7V (not valid)

<u>***D1 OFF, D2 OFF***</u>

(b) V_{D2}= V_{CC}-V_{EE}= 20V (not valid)

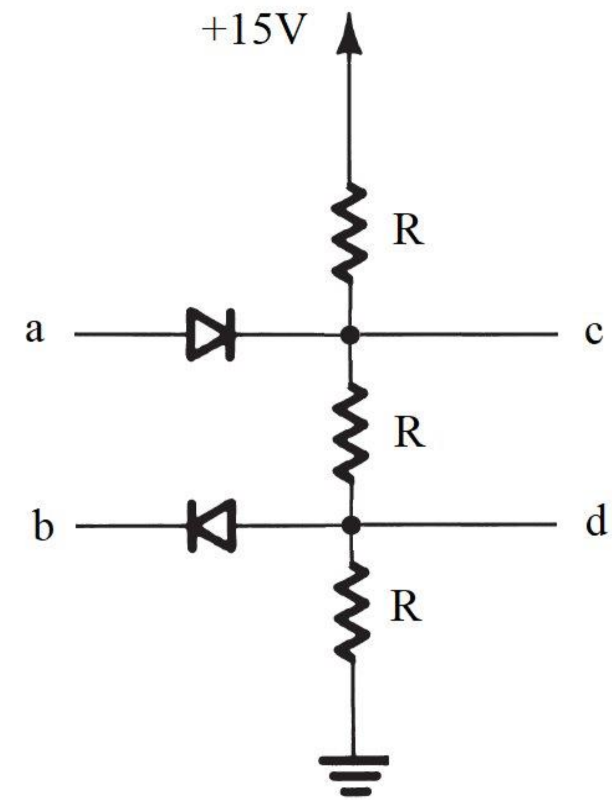
<u>***D1 OFF, D2 ON***</u>

(b) V_{CC}- $(R_1 + R_2)\, I_{D2}$ – V_{D2}=V_{EE}

I_{D2} =(V_{CC}- V_{EE}- V_{D2})/ $(R_1 + R_2)$ =(10- (-10)-0.7)/15k=12.9mA (valid)

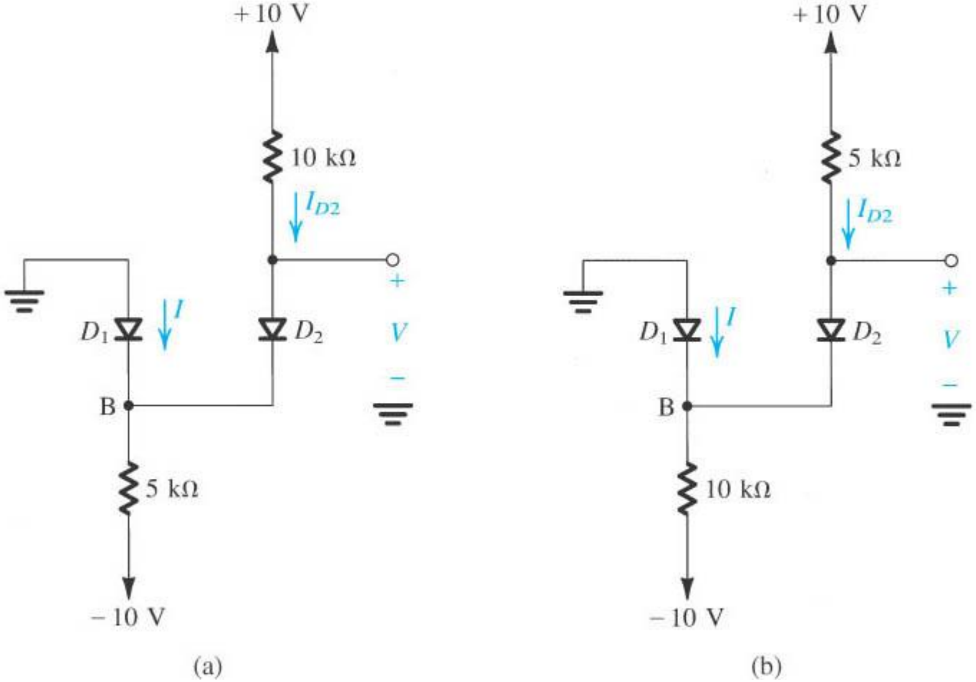
V_x =V_{D1} =-10V+5k 12.9mA+0.7=-2.86V (valid)

In figure, assume ideal diode model (V_D=0V) for the diodes. Calculate all possible output voltages. Input voltage (a,b) values are 15V or 0V.



A	B	C	D
0 V	0 V	7,5 V	0 V
0 V	15 V	10 V	5 V
15 V	0 V	15 V	0 V
15 V	15 V	15 V	7,5 V

In figure, assume modified ideal diode model (V_D=0.7V) for the diodes. Calculate output voltage.



D1 ON, D2 OFF

(b) V_{D2}= 10V-(-V_{D1})= 10.7V (not valid)

D1 OFF, D2 OFF

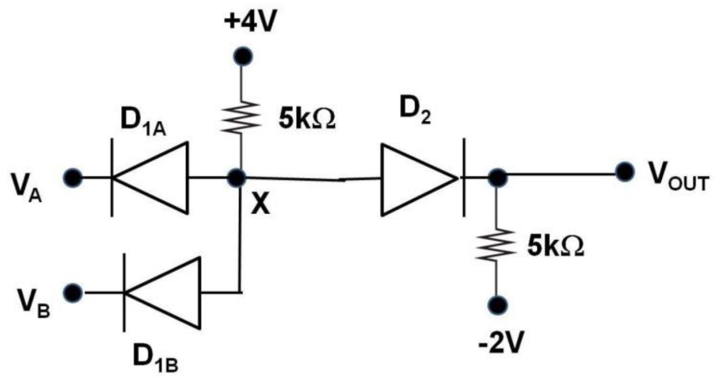
(b) V_{D2}= 10-(-10) = 20V (not valid)

D1 OFF, D2 ON

(b) 10V - 15k I_{D2} – V_{D2}= -10V , I_{D2} =1.28mA (valid)

$V_B = -V_{D1}$ =-10V+10k 1.28mA=2.8V (valid)

All PN diodes shown below have a voltage drop of 0.6V when they are "ON". Calculate output voltage with the given values (V_a=4V, V_b=3V).



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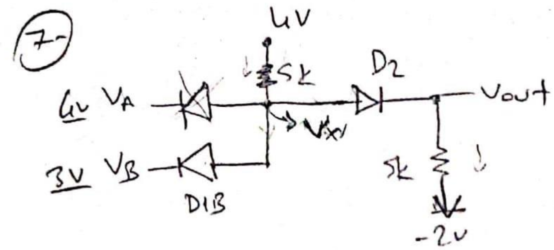

D1B on, D2 on

$V_x = 3{,}6V$ $\qquad V_{out} = 3V$

$\frac{4-3{,}6}{5k} = 0{,}08\,mA$ $\qquad \frac{3V-(-2V)}{5k} = \frac{5V}{5k} = 1\,mA$

(invalid)

D1B off, D2 on

$4V - 5k\,I_{D2} - \overset{0{,}6V}{V_{D2}} - 5k \cdot I_{D2} = -2V$

$5{,}4 = 10k\,I_{D2}$

$I_{D2} = 0{,}54\,mA$

$V_x = 4 - 5k \cdot 0{,}54\,mA = 1{,}3V$

$V_{D1B} = 1{,}3V - 3V = -1{,}7V$

(Valid)

$V_{out} = -2V + 5k \cdot 0{,}54\,mA = 0{,}7V$