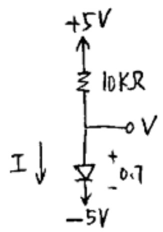
# HW #3 solution



3.59

(a)

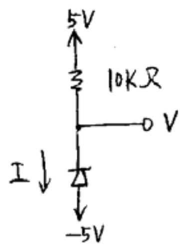



Using constant-voltage-drop model ($V_D = 0.7V$)

$V = -5V + 0.7V = -4.3V$

$$I = \frac{5 - (-4.3)}{10K} = 0.93\ mA$$

(b)

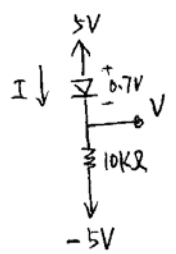



Diode is off

$I = 0$

$V = 5V$

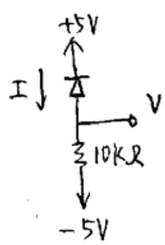
(c)




$V = 5 - 0.7 = 4.3V$

$$I = \frac{4.3 - (-5)}{10K} = 0.93\ mA$$

(d)

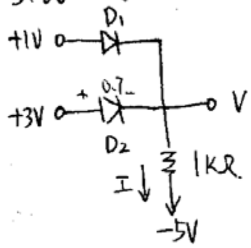



Diode is off

$I = 0$

$V = -5V$

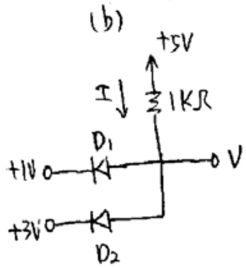
3.60 (a)




$D_1$ off
$D_2$ on
$\Rightarrow \quad V = 3 - 0.7 = 2.3V$

$$I = \frac{2.3V - (-5V)}{1K\Omega} = 7.3mA$$

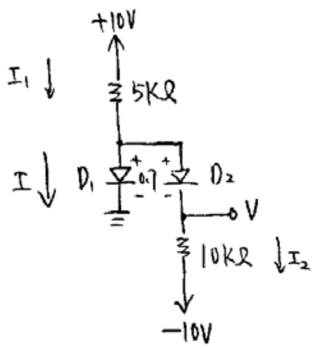
(b)




$D_2$ off
$D_1$ on
$\Rightarrow \quad V = 1.7V$

$$I = \frac{5V - 1.7V}{1K\Omega} = 3.3mA$$

3.61 (a)

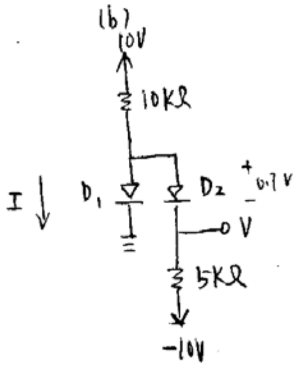



$D_1$ $D_2$ both on

$\Rightarrow \quad V = 0$

$$I = I_1 - I_2 = \frac{10-0.7}{5K\Omega} - \frac{0-(-10)}{10K\Omega} = 0.86mA$$

(b)

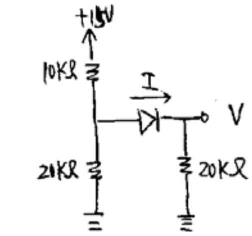



$D_1$ off
$D_2$ on
$\Rightarrow \quad I = 0$

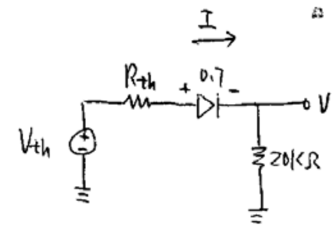
$$\Rightarrow V = \frac{10V - (-10V) - 0.7V}{10K\Omega + 5K\Omega} \cdot 5K\Omega + (-10V)$$

$$= -3.55V$$

3.62 (a)




$\Rightarrow$



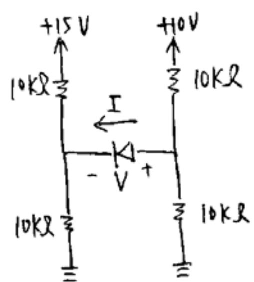

$$V_{th} = \frac{20K\Omega}{10K\Omega + 20K\Omega} \cdot 15V = 10V$$

$$R_{th} = 10K\Omega // 20K\Omega = 6.67K\Omega$$

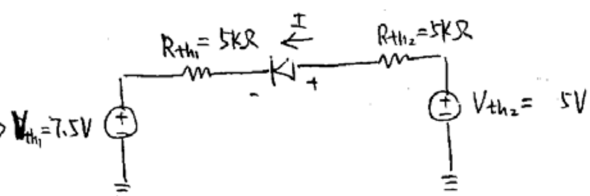
$$V = \frac{V_{th} - 0.7}{R_{th} + 20K\Omega} \cdot 20K\Omega = 7V$$

$$I = \frac{V_{th} - 0.7}{R_{th} + 20K\Omega} = 0.35mA$$

(b)




$\Rightarrow$

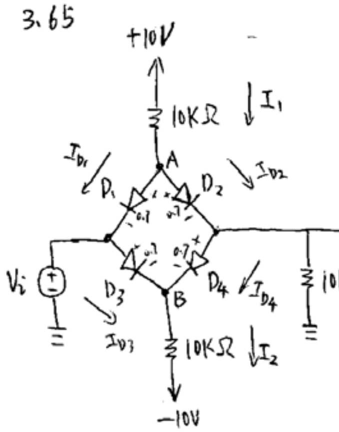



Diode is off

$I = 0$

$V = 5V - 7.5V = -2.5V$

3.65




① For $V_i$ close to zero

$D_1$ $D_2$ $D_3$ & $D_4$ are on

$V_o = V_i$ (As long as all four diodes on)

$$I_1 = \frac{10 - V_i - 0.7}{10K\Omega} = \frac{9.3 - V_i}{10K\Omega}$$

$$I_2 = \frac{10 + V_i - 0.7}{10K\Omega} = \frac{9.3 + V_i}{10K\Omega}$$

$$I_L = \frac{V_i}{10K\Omega}$$

As $V_i$ increases in the positive Direction, $I_1$ decreases & $I_L$ increases

Note that $I_1 > I_{D_2}$ for $D_1$ $D_2$ both on and $I_{D_2} > I_L$ for $D_2$ $D_4$ both on

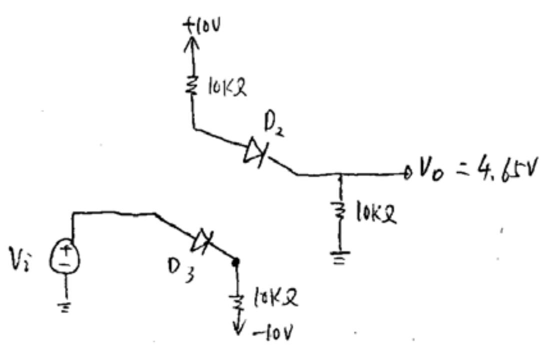
$\Rightarrow$ $I_1 > I_{D_2} > I_L$

Now as $I_L$ increases and $I_1$ decreases, a value for $V_i$ will be reached at which this condition is no longer satisfied. This boundary is reached when $I_1 = I_{D_2} = I_L$, At this point, $D_1$ $D_4$ turn off

$$I_1 = \frac{9.3 - V_i}{10K\Omega} = \frac{V_i}{10K\Omega} = I_L$$

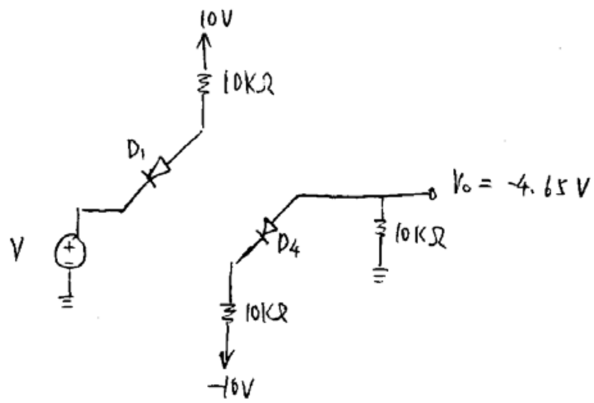
$$\Rightarrow V_i = 4.65\ V$$

For $V_i \geqslant 4.65\,V$, $D_1$ $D_4$ off and $D_2$ $D_3$ on. and the oringinal circuit is reduced to



observe that $V_o$ remains constant at 4.15V for $V_i \geq 4.65V$

The symmetry of the circuit indicates that a ~~p~~ similar limiting situation occurs at a negative value of $V_i$. specifically, for $V_i \leq -4.65$, $D_2$ $D_3$ off and $D_1$ $D_4$ on. the circuit reduces to




observe that $V_o$ remains constant at $-4.65V$. In conclusion, the given circuit provides :

$$V_o = V_I, \quad -4.65 \leq V_i \leq 4.65$$

$$V_o = 4.65V, \quad V_i \geq 4.65\ V$$

$$V_o = -4.65V, \quad V_i \leq -4.65V$$