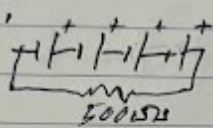


3.21

24h;  
 a)   $V = 4V_B = 4 \left( 6 - \frac{5I_d t \cdot 75}{2.7} \right)$   
 $= 6 - \frac{5I_d t \cdot 3}{2.7}$

$$V = \frac{I}{500} = 6 - \frac{5I_d t \cdot 3}{2.7}$$

$$\Rightarrow 500I + \frac{3}{2.7} 5I_d t = 6$$

$$\Rightarrow 500\dot{I} + \frac{3}{2.7} I = 0$$

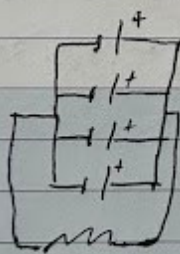
$$\Rightarrow \dot{I} + \frac{3}{1350} I = 0$$

$$\Rightarrow I(t) = C e^{-\frac{3}{1350} t} \quad \& \quad I(0) = \frac{6}{500} \Rightarrow C = \frac{6}{500}$$

$$\Rightarrow I(t) = \frac{6}{500} e^{-\frac{3}{1350} t}$$

$$t_{\text{end}} \text{ when } V=3 \Rightarrow I(t_{\text{end}}) = \frac{3}{500} = \frac{6}{500} e^{-\frac{3}{1350} t}$$

$$\Rightarrow t_{\text{end}} = \sim 312 \text{ hours or } \sim 13 \text{ days}$$

b)   $V = 1.5 - \frac{5I_d t \cdot 75}{4(2.7)}$   
 $= 1.5 - \frac{75}{10.8} 5I_d t$   
 $V = 500I = 1.5 - \frac{75}{10.8} 5I_d t$   
 $500\Omega \Rightarrow 500I + \frac{75}{10.8} 5I_d t = 1.5$

$$\Rightarrow 500\dot{I} + \frac{75}{10.8} I = 0$$

$$\Rightarrow \dot{I} + \frac{75}{5400} I = 0$$

$$\Rightarrow I(t) = C e^{-\frac{75}{5400} t} \quad \& \quad I(0) = \frac{1.5}{500} \Rightarrow C = \frac{1.5}{500} = .003$$

$$t_{\text{end}} \text{ when } V=.75 \Rightarrow I(t_{\text{end}}) = \frac{.75}{500} = \frac{1.5}{500} e^{-\frac{75}{5400} t}$$

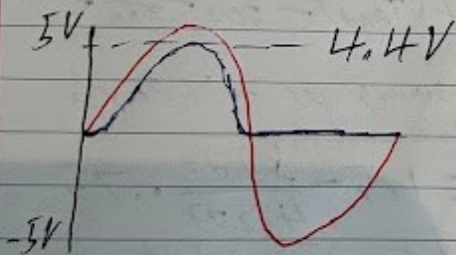
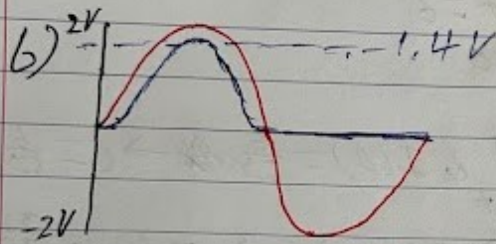
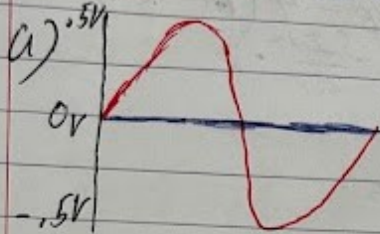
$$\Rightarrow t_{\text{end}} = 4987 \text{ hrs or } 208 \text{ days}$$



3.4°

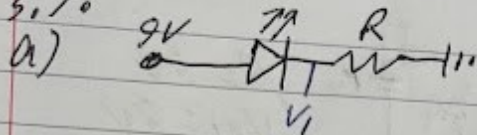
$V_{in}$

$V_{out}$



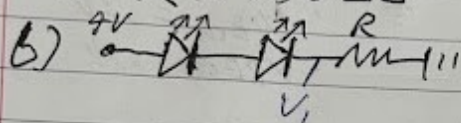


3.7°



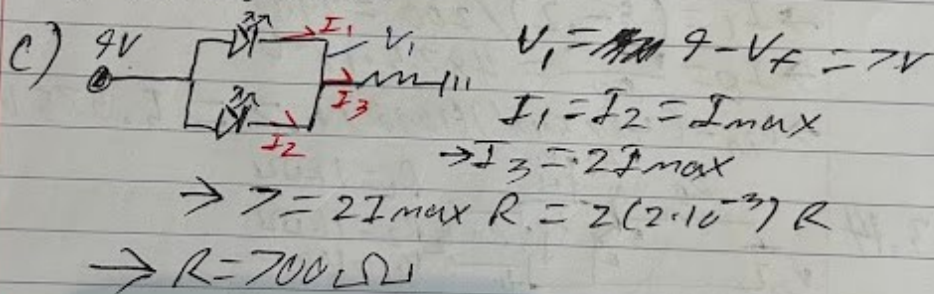
$$V_1 = 9 - V_f = 7 = I_{\max} R = (60 \cdot 10^{-3}) R$$

$$\rightarrow R = 350 \Omega$$



$$V_1 = 9 - 2V_f = 5 = I_{\max} R = (60 \cdot 10^{-3}) R$$

$$\rightarrow R = 250 \Omega$$



$$V_1 = 9 - V_f = 7V$$

$$I_1 = I_2 = I_{\max}$$

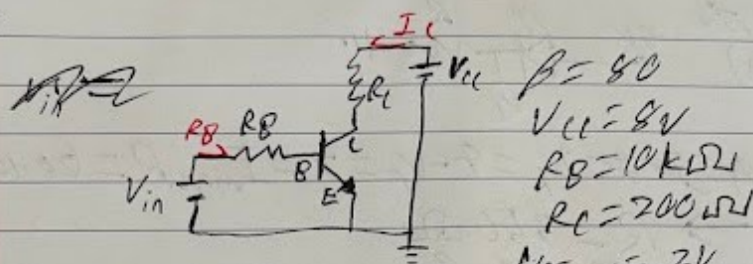
$$\rightarrow I_3 = 2I_{\max}$$

$$\rightarrow 7 = 2I_{\max} R = 2(2 \cdot 10^{-3}) R$$

$$\rightarrow R = 700 \Omega$$



3.13



$\beta = 80$   
 $V_{CC} = 8V$   
 $R_B = 10k\Omega$   
 $R_C = 200\Omega$   
 $V_{CEsat} = 0.2V$   
 $V_{BEsat} = 0.7V$

$$V_{in} = I_B R_B + V_{BE}$$

$$I_B = I_C / \beta$$

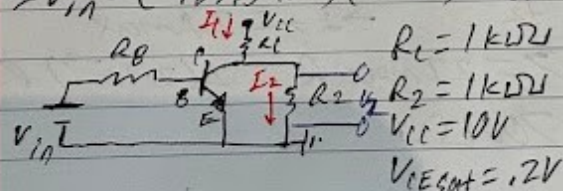
$$I_C = (V_{CC} - V_{CE}) / R_C$$

$$\rightarrow I_C = (8 - 0.2) / 200 = 39 \cdot 10^{-3}$$

$$\rightarrow I_B = \frac{39 \cdot 10^{-3}}{80} = 487.5 \cdot 10^{-6}$$

$$\rightarrow V_{in} = (487.5 \cdot 10^{-6}) (10 \cdot 10^3) + 0.7 = 5.575V$$

3.14



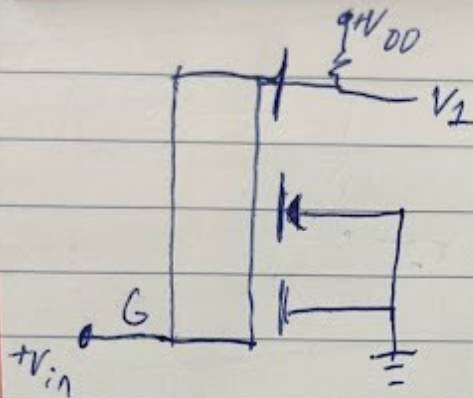
$R_C = 1k\Omega$   
 $R_2 = 1k\Omega$   
 $V_{CC} = 10V$   
 $V_{CEsat} = 0.2V$

~~$V_{CEsat} = 0.2V$~~   
 ~~$V_{BEsat} = 0.7V$~~   
 a)  $I_2 = I_C = \frac{V_{CC}}{R_C + R_2} = \frac{10}{2 \cdot 10^3}$   
 $\rightarrow I_2 = 5mA$

b)  $V_2 = V_{CEsat} = 0.2V = I_2 R_2 = I_2 \cdot 1 \cdot 10^3$   
 $\rightarrow I_2 = 0.2mA$



3.21



$$V_T = 1V$$

$R_{DS(on)} \downarrow \downarrow$

a) if  $v_{in} = 0$   $V_1 = 5V$

b) if  $v_{in} = 5V$   $V_1 = 0V$

