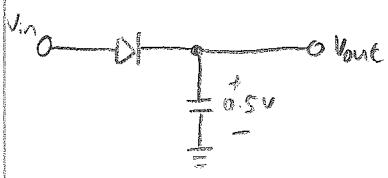
ECEn 740 Section 1
Homework 3

3: 34, 46
4: 4, 7, 14

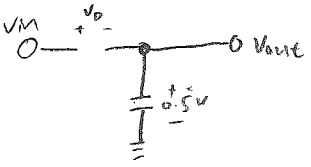
Benjamin Bergeson

3.34

$V_{in} = 5 \sin \omega t$ +0.5V across C_1 $V_D = 5V$



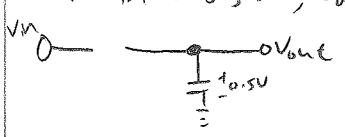
@ time = 0



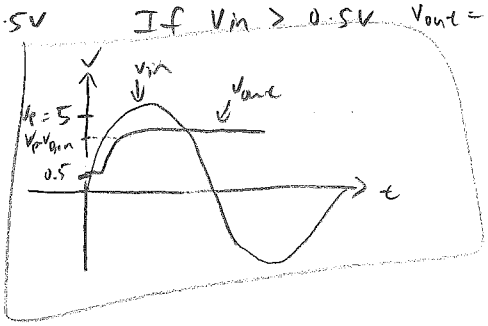
If $V_{in} = 0.5V$ $V_D = 0$

$V_{out} = 0.5V$

If $V_{in} < 0.5V$; $V_{out} = 0.5V$

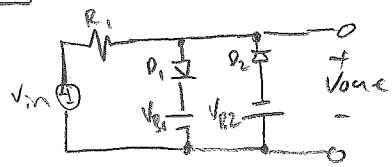


If $V_{in} \geq 0.5V$ $V_{out} = V_{in} - V_{D,on}$

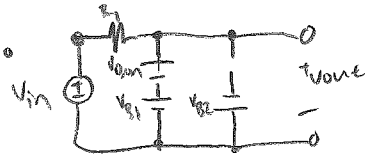


3.46

plot current D_1 and D_2 vs. time $V_{in} = V_0 \cos \omega t$ $V_0 > V_{D,on} + V_{B1}$ $-V_0 > -V_{D,on} - V_{B2}$



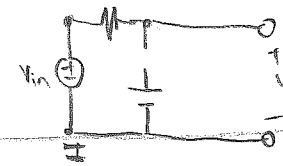
@ time = 0



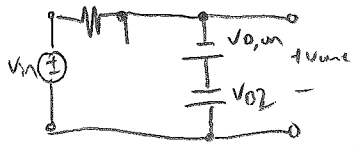
$ID_1 = \frac{V_{in} - V_{D,on} - V_{B1}}{R_1}$

$ID_2 = 0$

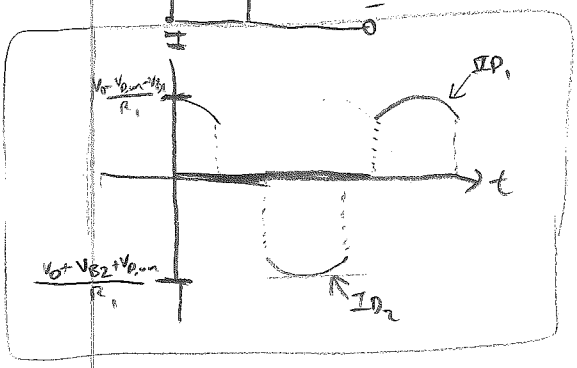
@ t_1 when $V_{in} < V_{D,on} + V_{B1}$; $D_1 = 0$



@ t_2 when $V_{in} < -V_{D,on} - V_{B2}$



$I_{D2} = \frac{V_{B2} + V_{D,on} + V_{in}}{R_1}$



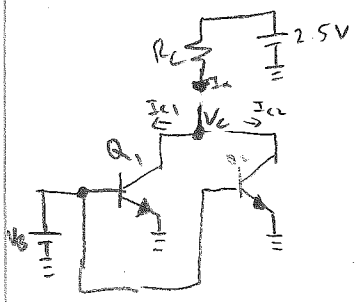
4.4

$I_C = I_S e^{V_{BC}/V_T} = \frac{A_E q D_n n_i^2}{N_B W_B} e^{V_{BC}/V_T}$

$I_C \propto \frac{1}{W_B}$

If W_B is doubled, then I_C would be halved.

4.7



$I_x = I_{C1} + I_{C2} = 1.2\text{mA}$

$\Rightarrow I_{S1} e^{V_{BT}/V_T} + I_{S2} e^{V_{BT}/V_T} = 0.0012\text{A}$

$\Rightarrow 5E\text{-}16\, e^{V_{BT}/V_T} + 2.5E\text{-}16\, e^{V_{BT}/V_T} = 6.0012\text{A}$

$\Rightarrow e^{V_{BT}/26\text{mV}} (5E\text{-}16 + 2.5E\text{-}16) = 0.0012\text{A}$

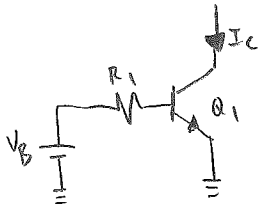
$\Rightarrow \boxed{V_{BT} = 730.627\text{mV} \quad (2)}$

(b) For active mode $V_C = V_B$ $\quad 2.5 = I_x R_C + V_B$ $\quad \frac{2.5 - V_B}{I_x} = R_C$

$\frac{2.5 - 0.730}{0.0012} = \boxed{R_C = 1475\,\Omega}$

4.14

$\beta = 100$ $\quad I_S = 7E\text{-}16\text{A}$ $\quad R_1 = 10\text{k}\Omega$ $\quad I_C = 1\text{mA}$



$I_C = I_S e^{V_B/V_T} \Rightarrow \frac{I_C}{I_S} = e^{V_B/V_T} \Rightarrow \ln\left(\frac{I_C}{I_S}\right) = \frac{V_B}{V_T} \Rightarrow V_T \ln\left(\frac{I_C}{I_S}\right) = V_B$

$V_B = 0.026 \ln\left(\frac{0.001}{7E\text{-}16}\right) = \boxed{0.7277\text{V} = 727.7\text{mV}}$