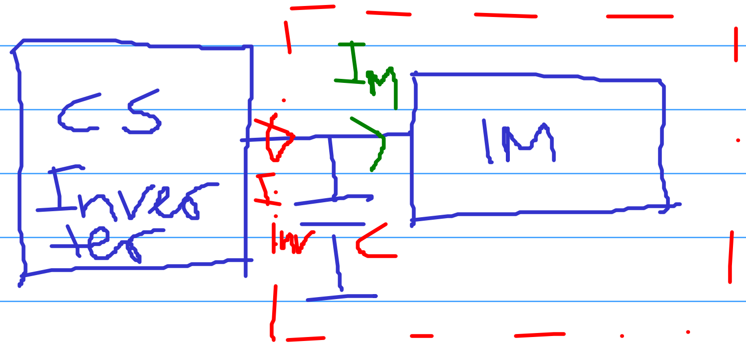


I_M could be lagging power factor, however I_{inv} is of leading power factor

500 hp, 4 pole, 415 V (L-L), 50 Hz squirrel cage IM $\rightarrow$ $S_{rated} = \underline{0.03}$ and

$S_{max} = \underline{0.12}$ $\bar{V}_p = 239.6\angle 0°$

$I_M = \underline{\underline{535A}}$ $\bar{I}_M = 535\angle -14°$

$\bar{I}_{INV} = ?\ \angle +15°$

$535\cos 14° = I_{INV}\cos 15°$

$I_{INV} = 537.42A$

$X_{C\Delta} = 3X \cdot 9$

$C_\Delta = \frac{1179\mu F}{3}$

$I_C = 535\sin 14° + 537.42\times\sin 15° = 268.52A$

$\bar{V}_p = 239.6 \Rightarrow X_C = \frac{239.6}{268.52} = 0.9\,\Omega$

$\frac{1}{\omega C} = X_C$

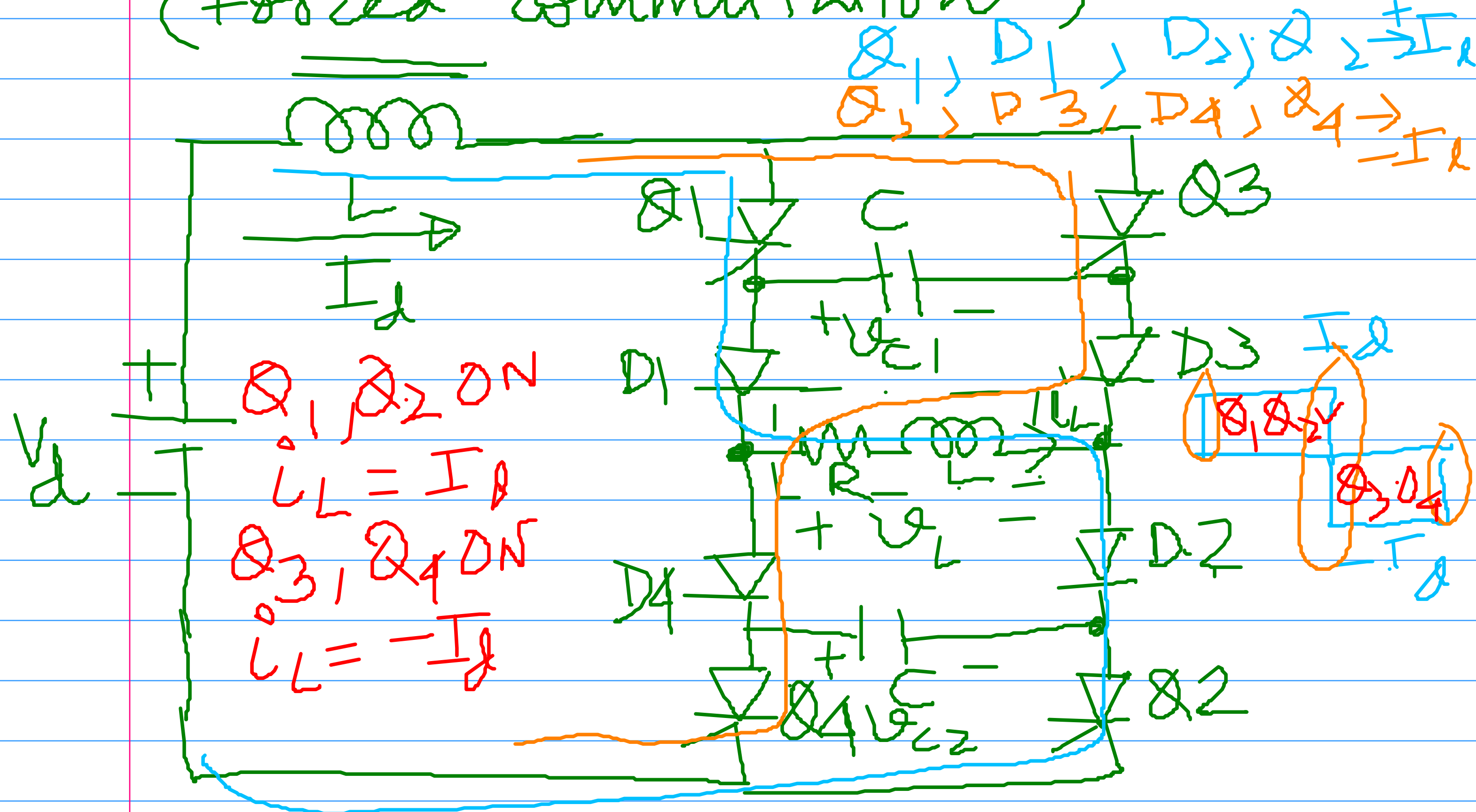
$C = \frac{1}{2\pi 50 \times 0.9}$

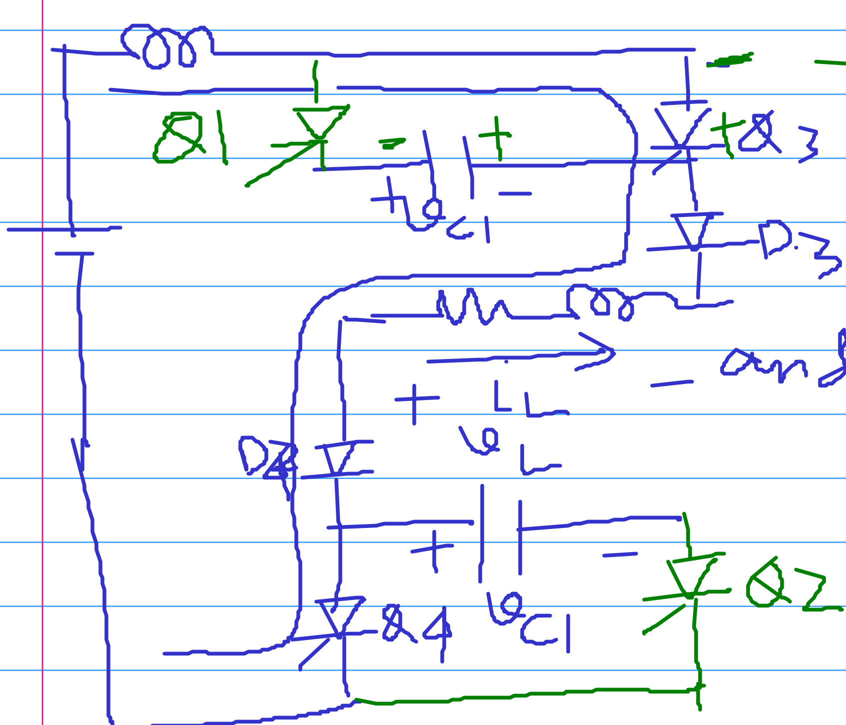
$= 3536\mu F$

415V

240V

Auto-sequential-commutated Inverter (ASCI)
(Forced commutation)

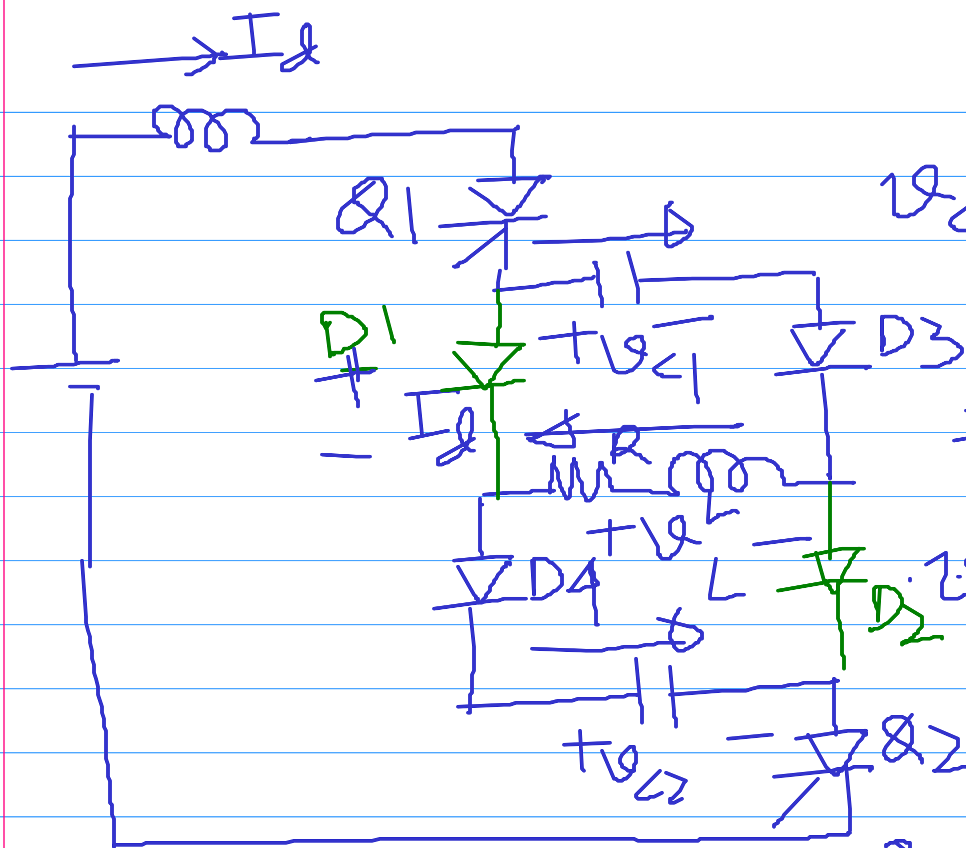




→ at the instant of turning off

$+v_{C1}(0) = v_{C0} < 0$

Q_1, Q_2 turns on and Q_3, Q_4 turns off



$I_d = \text{const}$

$v_{c1} = v_{c2}$

$= V_{cD} + \frac{1}{C}\int I_d\,dt$

$= V_{cD} + \frac{I_d t}{C}$

$v_L = -I_d R$

~~At~~ Let's say this mode ends at $t = t_1$ when $D1, D2$ becomes forward biased

$\cancel{v_D =}\ v_D = v_{c1} - v_L$

$$0 = \underbrace{V_{cD} + \frac{I_d t_1}{C}}_{v_c} + I_d R$$

$V_c = -I_d R$ at $t = t_1$

$-V_{cD} = v_c(t=0)$

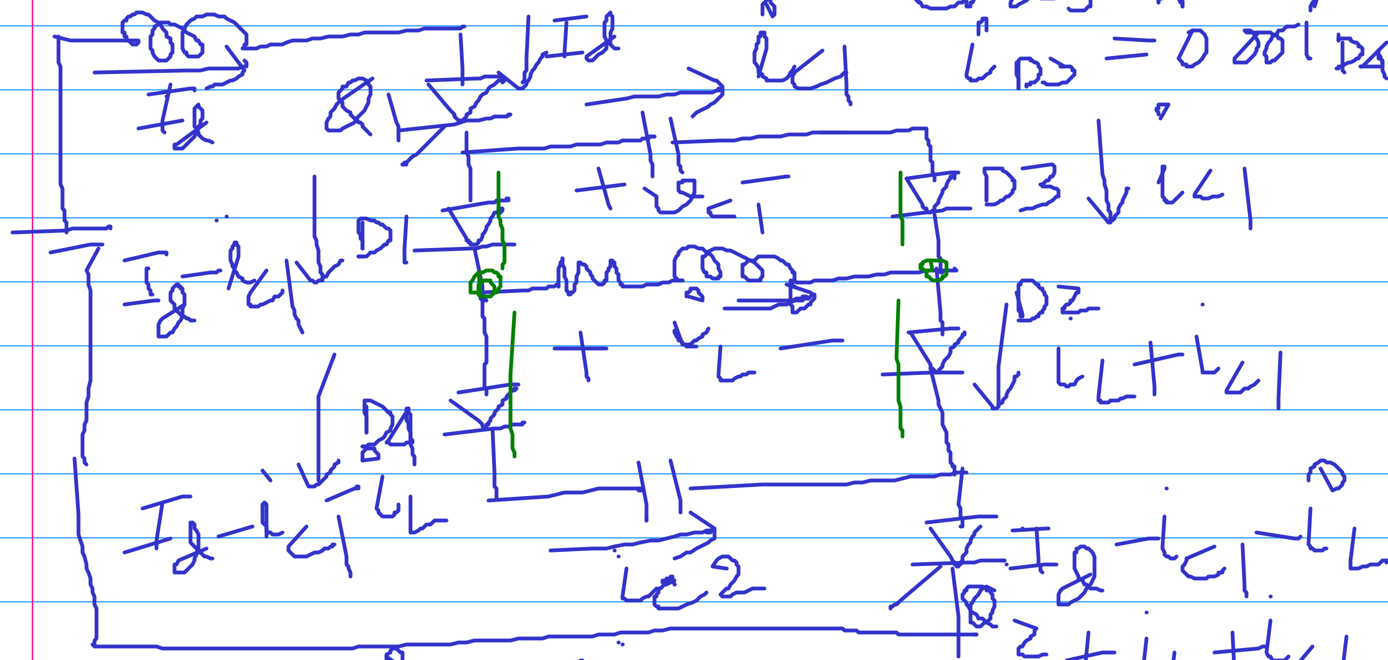
$-I_d R = v_c(t = t_1)$

$$C\frac{dv_c}{dt} = i_c \qquad \frac{C \times [-I_d R + V_{cD}]}{t_1} = -I_d$$

Later after V_{CD} is ~~...~~

$$t_1 = \frac{\cancel{20}\ 10\mu\,[-256 + 328\cancel{6}]}{594} = \underline{\underline{5\cancel{1}0\,\mu sec}}$$

This mode ends when $i_{D3} = 0$ or $i_{D4} = 0$



$+ i_L + i_{C1} = I_d$

$$v_L = v_C = R i_L + L\frac{di_L}{dt} \checkmark$$

$$\frac{di_L}{dt} = \frac{v_C - R i_L}{L}$$

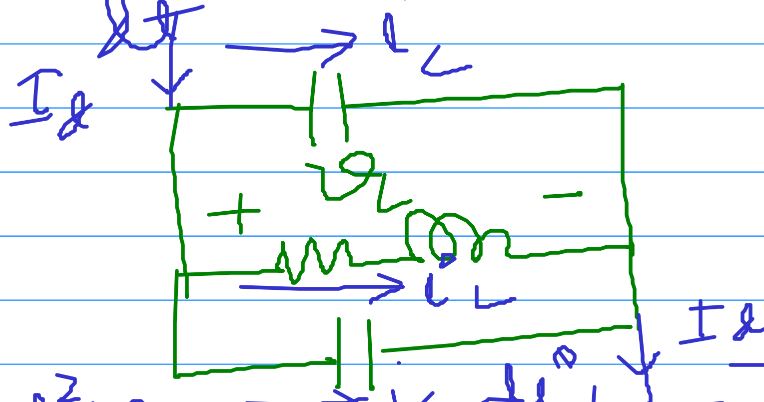
$$i_{C2} = I_d - i_{C1} - i_L$$

$$v_{C1} = v_{C2}$$

$$\boxed{i_{C2} + i_{C1} = I_d - i_L}$$

$$C\frac{dv_C}{dt} + C\frac{dv_C}{dt} = I_d - i_L$$

$$2C\frac{dv_C}{dt} = I_d - i_L \checkmark$$



4

$$2C\frac{d^2 v_C}{dt^2} = -\frac{di_L}{dt} = -\frac{v_C + R i_L}{L}$$

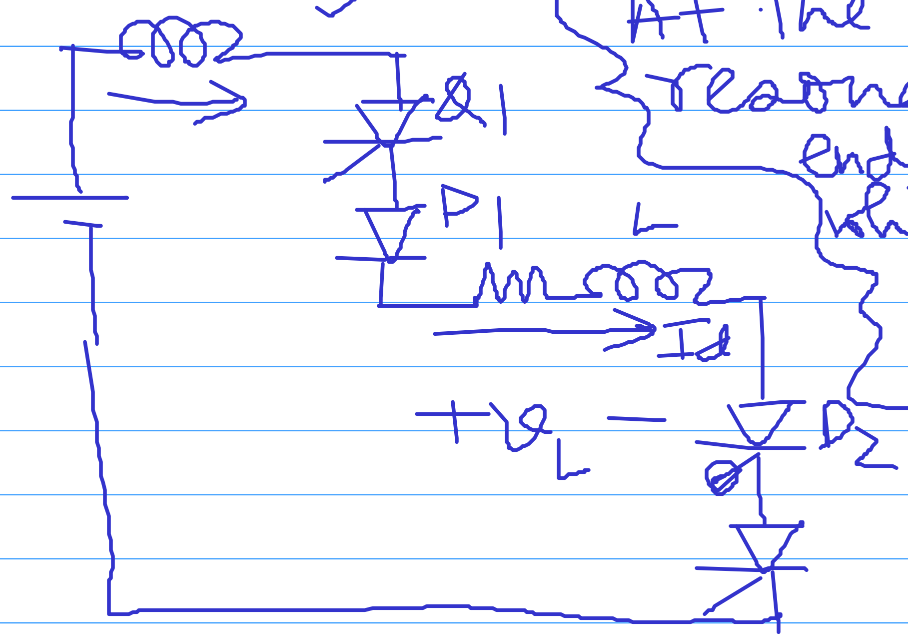
$$2LC \frac{d^2 v_c}{dt^2} + v_c = R i_L$$

$$= R \left(I_d - 2 i_c \right)$$

$$= R I_d - 2RC \frac{dv_c}{dt}$$

$$\boxed{2LC \frac{d^2 v_c}{dt^2} + 2RC \frac{dv_c}{dt} + v_c = R I_d}$$

$$v_c(t) = \underline{\underline{R I_d}} + \underline{\underline{e^{-\delta t}}} \left(A \sin \omega t + B \cos \omega t \right)$$



At the end of the resonant mode ends when $i_{D3} = 0$

$i_{D4} = 0$

$$2LC\frac{d^2v_C}{dt^2} + 2RC\frac{dv_C}{dt} + v_C = RI_d$$

$$v_C(0) = -I_dR$$

$$2i_C = I_d - i_L$$

$$2\frac{dv_C}{dt} = I_d - i_L$$

$$2\frac{dv_C}{dt}(0) = I_d - i_L(0)$$

$$= 2I_d \quad \rightarrow i_L(0) = -I_d$$

$$\frac{dv_C}{dt}(0) = \frac{I_d}{C}$$

$$v_C(t) = I_dR + e^{-\sigma t}(A\sin\omega t + B\cos\omega t)$$

$$\sigma = \frac{R}{2L} \qquad \omega = \sqrt{\omega_0^2 - \sigma^2}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$v_C(0) = I_dR + B \Rightarrow B = v_C(0) - I_dR$$

$$= -I_dR - I_dR$$

$$= -2I_dR$$

$$\frac{dv_C(t)}{dt} = e^{-\sigma t}(-\sigma)A\sin\omega t + e^{-\sigma t}A\omega\cos\omega t + e^{-\sigma t}(-\sigma)B\cos\omega t + e^{-\sigma t}B\omega(-\sin\omega t)$$

$$\frac{dv_C}{dt}(t=0) = A\omega - B\sigma$$

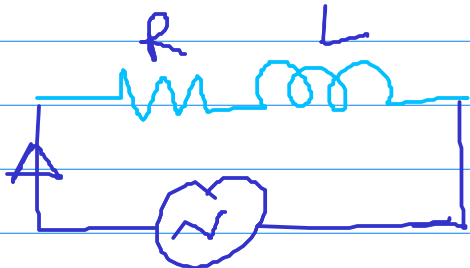
$$A = \frac{\frac{I_d}{C} + \left(-2I_dR \times \frac{R}{2L}\right)}{\omega}$$

$$A = \frac{I_d}{\omega}\left[\frac{1}{C} - \frac{R^2}{L}\right]$$

$Q_3, Q_4 \rightarrow$ outgoing thyristors

$\underline{\underline{t_2}}$

535A
∠14°



$V_p = 234.6$

$$\frac{4 I_d}{\pi} = 535\sqrt{2}$$

$$I_d = 594\text{ A}$$

$$|Z| = \frac{234.6}{535} = .4478$$

$$\frac{\omega_s L}{R} = \tan 14°$$

$$\omega_s L = .10862$$

$$L = \frac{.1086}{2\pi \times 50} = 345.7\,\mu H$$

$$\delta = \frac{R}{2L} = \frac{0.4344}{2 \times 345.7} = 628.32$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$C = 10\,\mu F$

$$= \frac{1}{\sqrt{345.7\mu \times 10\mu}} = 17007.9$$

$$\omega = \sqrt{\omega_0^2 - \delta^2} = 16996$$

$$B = -2 I_d R = -2 \times 594 \times .4344 = -516.$$

$$A = \frac{\frac{I_d}{C} - I_d \frac{R^2}{L}}{\omega} = 3475.86$$

$$I_d R = 594 \times .4344 = 258$$

During t_2 interval

$$v_c(t) = 258 + e^{-628t}\left(3475\sin\omega t - 516\cos\omega t\right)$$

$$v_c(t_2) = V_{c0}$$

$$i_L(t_2) = I_d$$

$$i_L(t) = I_d - 2C\frac{dv_c}{dt}$$

$$\frac{d}{dt}v_c(t) = e^{-628t}\left[3475\omega\cos\omega t + 516\omega\sin\omega t\right] - 628e^{-628t}\left[3475\sin\omega t - 516\cos\omega t\right]$$

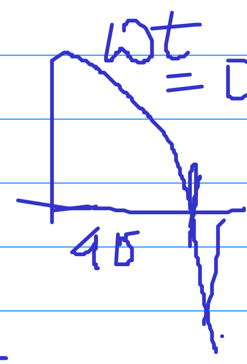
$$i_L(t) = I_d - 20\times10^{-6}\times e^{-628t}\{3475\omega\cos\omega t + 516\omega\sin\omega t + 3475\times628\sin\omega t - 516\times628\cos\omega t\}$$

At what value of t_2, $i_L(t_2) = I_d$

$$i_L(t) = I_d - 20\times10^{-6}\times e^{-628t}\{58765\cos\omega t + 10956\sin\omega t\}$$

$$\omega t_2 = 120^\circ \Rightarrow \frac{2\pi}{3}$$

$$t_2 = \frac{2\pi}{3\times16996} = 123.2\,\mu sec$$



20 msec

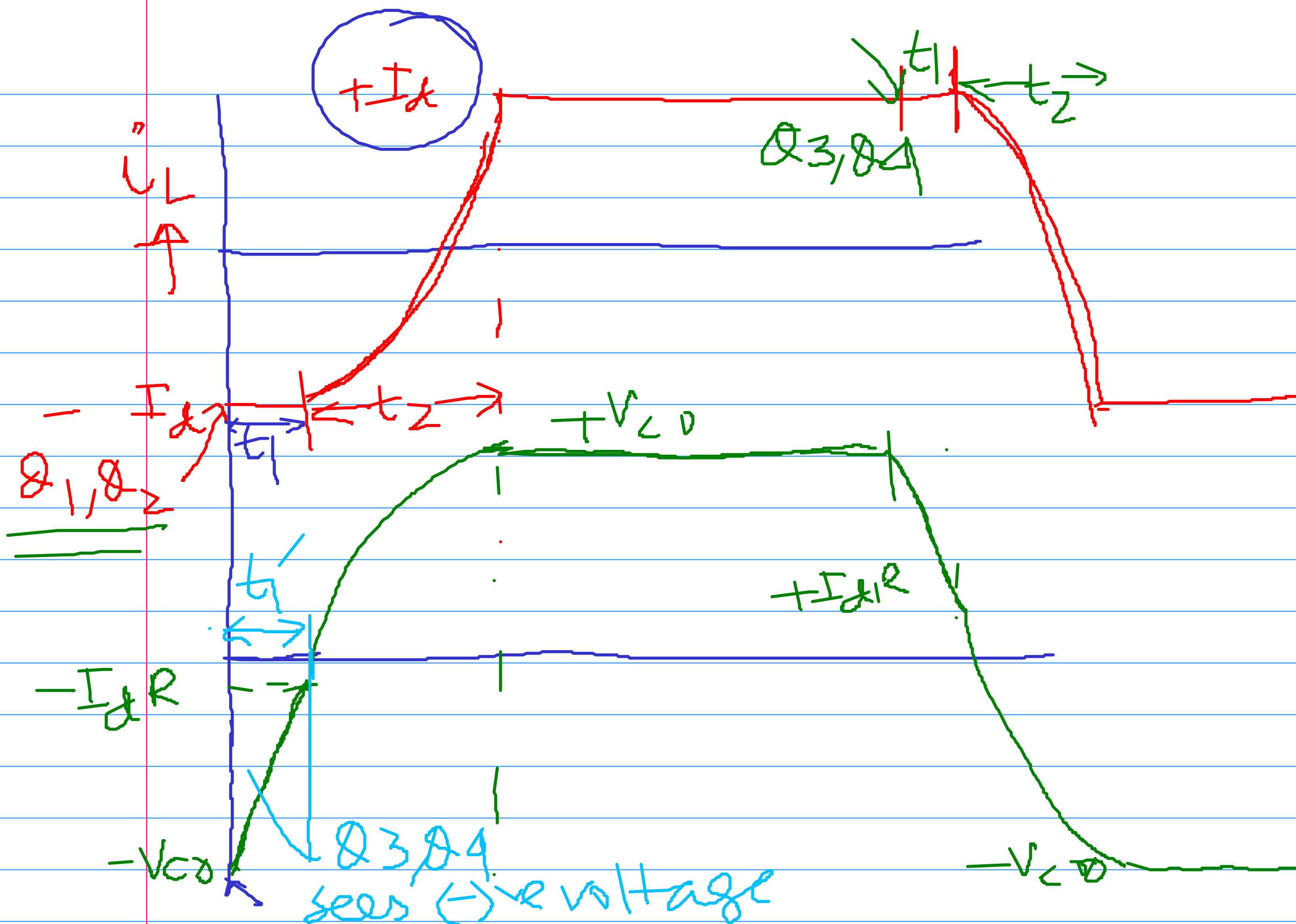
10 msec

123.2 μ

$$v_c(t_2) = 258 + e^{-628\times 123\times 10^{-6}}\left\{3475\sin 120^\circ - 516\cos 120^\circ\right\}$$

$$= 258 + .9256\times 3268$$

$$= \underline{\underline{3286\ V}} = V_{c0}$$



i_L
$+I_d$
$-I_d$
Q_1, Q_2
t_1
t_2
Q_3, Q_4
$+V_{cD}$
$+I_dR$
$-I_dR$
$-V_{cD}$
$Q_3\,Q_4$ sees $(-)$ve voltage