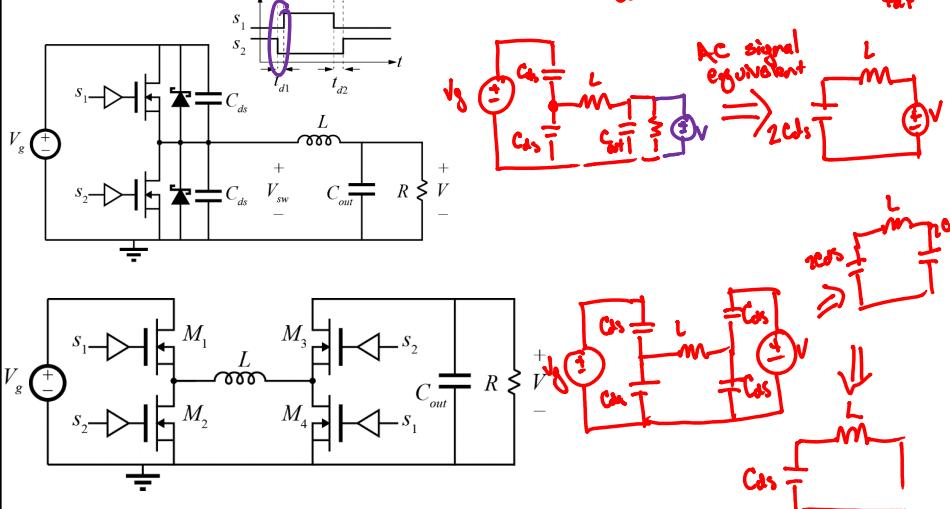


Time-Domain Analysis of Switching Transitions

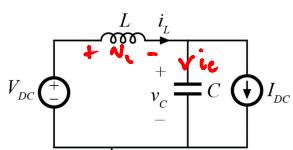
- (1) Assume C_{ds} is linear (by equivalent)
 (2) Assume $C_{out} \gg C_{ds} \rightarrow N_{out} \approx V$ during test



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Resonant Circuit Solution

General Examples



$$(1) v_L = V_{DC} - v_C = L \frac{di_L}{dt}$$

$$(2) i_C = i_L - I_{DC} = C \frac{dv_C}{dt}$$

combine

$$V_{DC} - v_C = L \frac{di_L}{dt} + C \frac{dv_C}{dt} + I_{DC}$$

Initial conditions:

$$@ t=0 \quad v_L(0) = V_0 \quad LC \frac{d^2v_C}{dt^2} + v_C - V_{DC} = 0$$

$$i_L(0) = I_0$$

$$v_L = V_{DC} + \sqrt{\frac{L}{C}} (I_0 - I_{DC}) \sin \frac{t}{\sqrt{LC}} + (V_0 - V_{DC}) \cos \frac{t}{\sqrt{LC}}$$

$$i_L = I_{DC} + (I_0 - I_{DC}) \cos \frac{t}{\sqrt{LC}} + \sqrt{\frac{L}{C}} (V_{DC} - V_0) \sin \frac{t}{\sqrt{LC}}$$

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Normalization and Notation

$$\text{Define } \frac{1}{R_L} + j\omega_0 = \frac{1}{jL} \quad R_0 = \sqrt{\frac{L}{C}}$$

$$V_L = V_{DC} + (V_0 - V_{DC}) \cos \omega t + (I_0 - I_{DC}) R_0 \sin \omega t$$

$$i_L = I_{DC} + (I_0 - I_{DC}) \cos \omega t + \frac{V_{DC} - V_0}{R_0} \sin \omega t$$

Normalization:

$$m_C(t) = \frac{v_L(t)}{V_{base}} \quad V_{base} \text{ is an "arbitrary" voltage}$$

$$j_L(t) = \frac{i_L(t)}{I_{base}} \quad I_{base} = \frac{V_{base}}{R_0}$$

$$\theta_0 = \omega_0 t$$

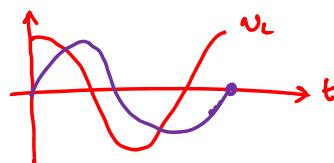
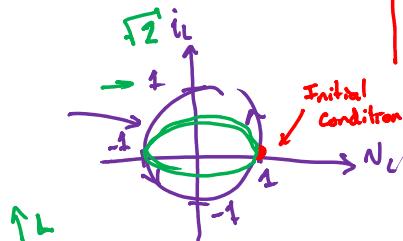
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Simple case:

$$V_0 = 1 \quad I_0 = 0 \quad \rightarrow \quad v_L = \cos t$$

$$V_{DC} = 0 \quad I_{DC} = 0$$

$$C = 1 \quad L = 1$$



$$\frac{1}{2}CV^2 \longleftrightarrow \frac{1}{2}LI^2$$

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$$v_c(t) = V_{DC} + (V_0 - V_{DC}) \cos\left(\frac{t}{\sqrt{LC}}\right) + (I_0 - I_{DC}) \sqrt{\frac{L}{C}} \sin\left(\frac{t}{\sqrt{LC}}\right)$$

$$i_L(t) = I_{DC} + (I_0 - I_{DC}) \cos\left(\frac{t}{\sqrt{LC}}\right) + (V_{DC} - V_0) \sqrt{\frac{C}{L}} \sin\left(\frac{t}{\sqrt{LC}}\right)$$

Pick $V_{base} > V_{DC}$ $\rightarrow I_{base} = \frac{V_{base}}{R_o}$

$$m_c(t) = 1 + \left(\frac{V_0}{V_{DC}} - 1\right) \cos\omega t + \frac{I_0 - I_{DC}}{V_{DC}} R_o \sin\omega t$$

$$j_L(t) = \frac{I_{DC} R_o}{V_{DC}} + \frac{R_o (I_0 - I_{DC})}{V_{DC}} \cos\omega t + R_o \left(1 - \frac{V_0}{V_{DC}}\right) \frac{1}{R_o} \sin\omega t$$

try $(m_c - 1)^2 + (j_L - \frac{I_{DC}}{I_{base}})^2$

$$= \left[A \cos\omega t + B \sin\omega t \right]^2 + \left[B \cos\omega t - A \sin\omega t \right]^2$$

$$= A^2 \cos^2 \omega t + B^2 \sin^2 \omega t + 2AB \cos\omega t \sin\omega t + B^2 \cos^2 \omega t + A^2 \sin^2 \omega t - 2AB \cos\omega t \sin\omega t$$

$$= A^2 + B^2 = \left(\frac{V_0}{V_{DC}} - 1\right)^2 + \left(R_o \frac{I_0 - I_{DC}}{V_{DC}}\right)^2$$