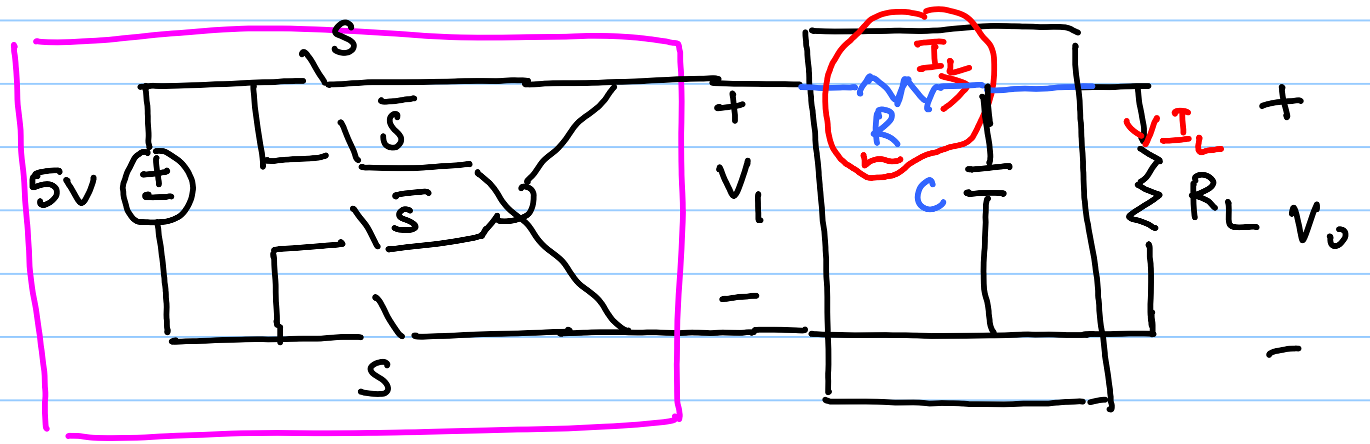
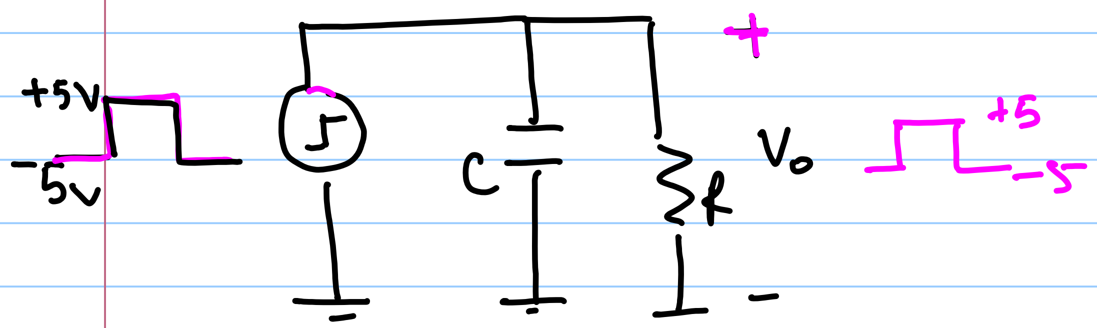
Note Title 04-03-2022

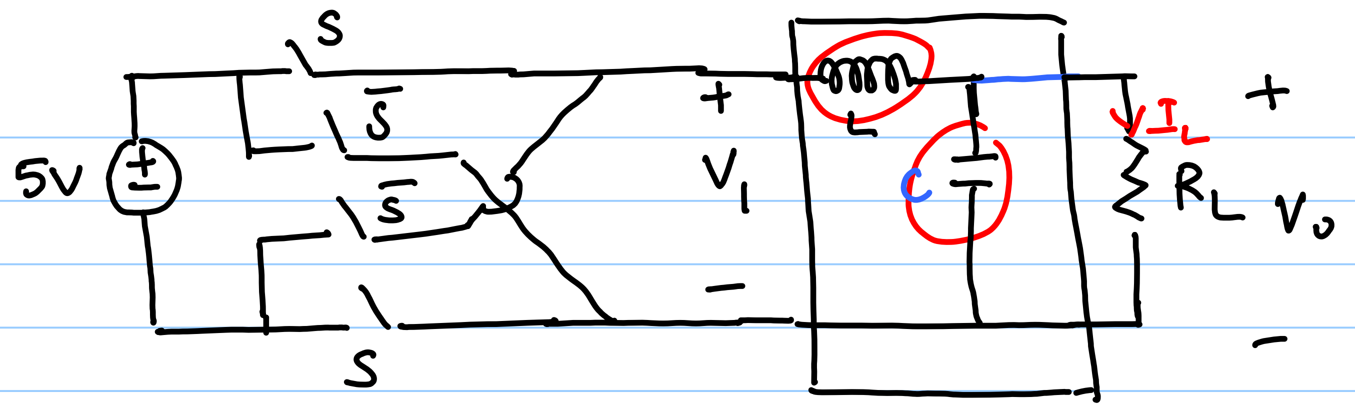
Lecture # 23

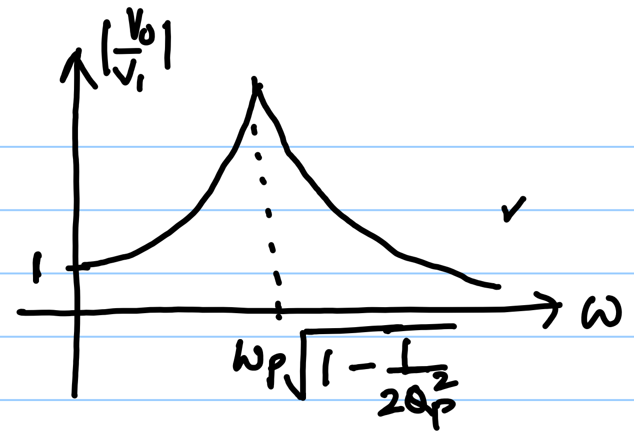


$$\frac{V_0}{V_1} = \frac{\left(R_L \| \frac{1}{sC}\right)}{\left(R_L \| \frac{1}{sC}\right) + R_1}$$

$$= \frac{R_L}{R_L + R}$$





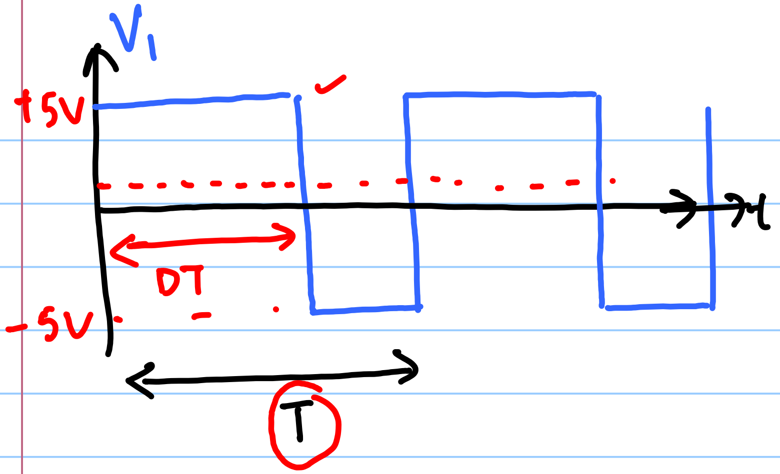


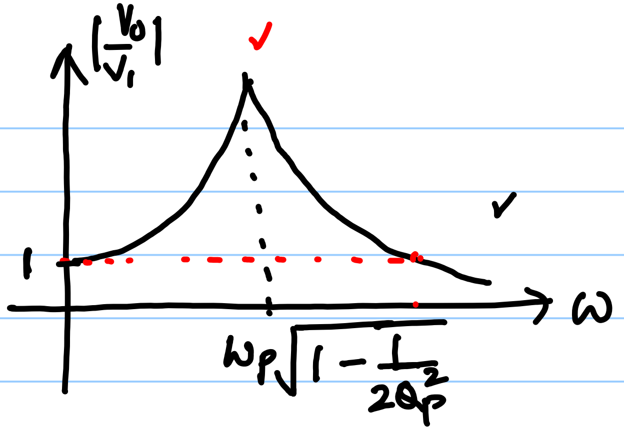
$$\frac{V_o}{V_1} = \frac{\left(R_L \| \frac{1}{sC}\right)}{\left(R_L \| \frac{1}{sC}\right) + sL} = \frac{R_L / 1+sCR_L}{\frac{R_L}{1+sCR_L} + sL} = \frac{R_L}{R_L + sL + s^2LC.R_L}$$

$$= \frac{1}{s^2LC + s\frac{L}{R_L} + 1} = \frac{1}{\left(\frac{s}{\omega_p}\right)^2 + \frac{s}{\omega_p Q_p} + 1}$$

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

$$\omega_p Q_p = \frac{R_L}{L} \Rightarrow Q_p = \sqrt{LC}\,\frac{R_L}{L} = R_L\sqrt{\frac{C}{L}}$$

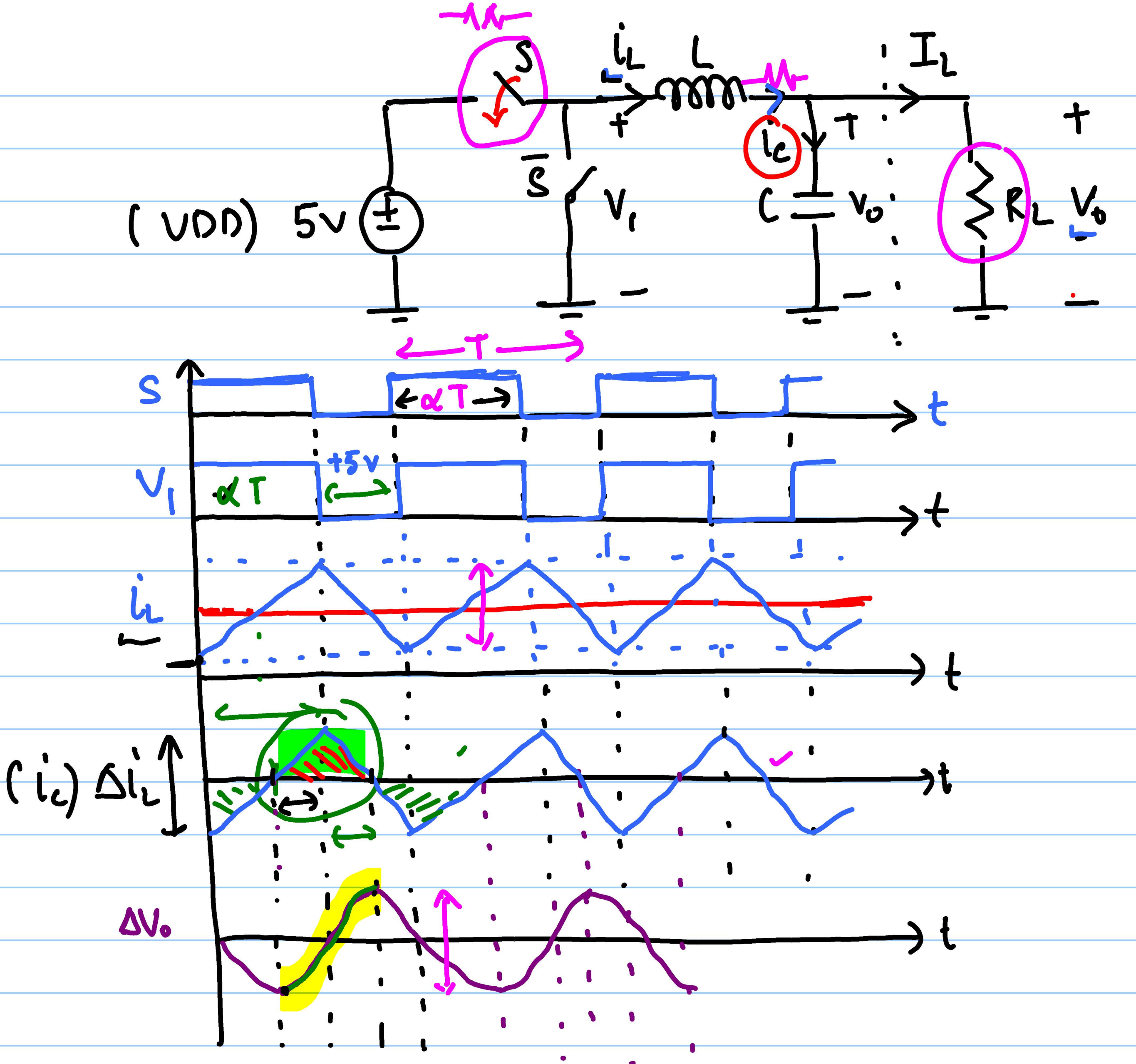




Sampling frequency, $f_s = \frac{1}{T}$, $\omega_s = 2\pi f_s = \frac{2\pi}{T}$

V_1 has dc component and frequency dependent components at nf_s.

$\omega_s \gg \omega_p\sqrt{1-\frac{1}{2Q_p^2}}$



$i_c = C \frac{dv_0}{dt} \Rightarrow \int dV_0 = \frac{1}{C} \int i_c \cdot dt$

- To find i_L, we assume V_0 is constant.
- When S is high,

$VDD - V_0 = L \frac{di_L}{dt}$ —(1)

$0 - V_0 = L \frac{di_L}{dt}$ —(2)

$i_L = \frac{VDD - V_0}{L} \cdot t$

$i_L = -\frac{V_0}{L} \cdot t$

$V_0 = \frac{\alpha T \cdot VDD + (1-\alpha) T \cdot 0}{T}$

$= \alpha VDD$

$\Delta i_L = \frac{VDD - \alpha VDD}{L} \cdot \alpha T$

$$\boxed{\Delta i_L = \frac{\alpha(1-\alpha)\, VDD}{L} \cdot T}$$

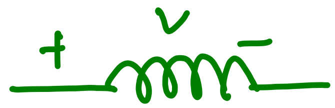
$$\Delta V_0 = \frac{\frac{1}{2}\left[\frac{\alpha T}{2} \cdot \frac{\Delta i_L}{2} + \frac{(1-\alpha)T}{2} \cdot \frac{\Delta i_L}{2}\right]}{C}$$

$$= \frac{1}{8C} T \cdot \Delta i_L \cdot (\alpha + (1-\alpha))$$

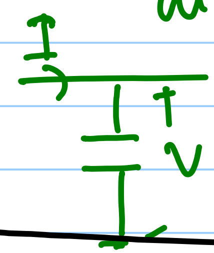
$$= \frac{1}{8C} T \, \alpha(1-\alpha) \, VDD \, \frac{T}{L}$$

$$= \frac{T^2}{8LC} \alpha(1-\alpha) \, VDD$$

$$\boxed{\Delta V_0 = \frac{1}{8LC f_s^2} \alpha(1-\alpha) \, VDD}$$



$V = L \frac{di}{dt}$



$V = \frac{1}{C} \int I \, dt$

- To minimize ΔV_0, increase f_s, L, C
  - Increasing L or C cost area
  - Increasing f_s, losses in switches will increase.
- Δi_L results in power loss in resistance in series w/ inductor

- Power efficiency of "Buck" converter is 95%.