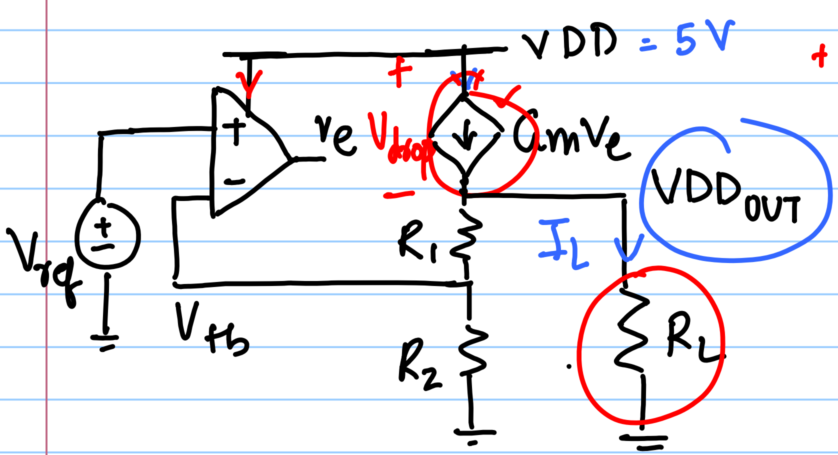
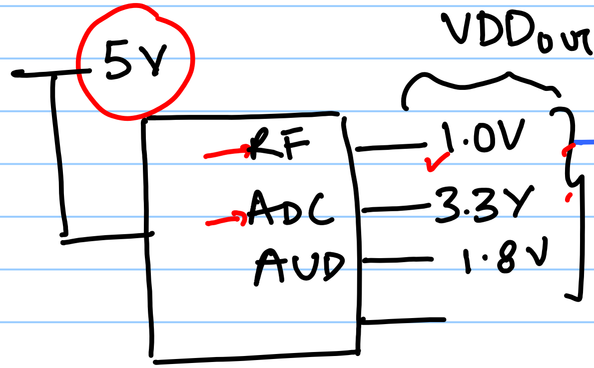
Note Title — lecture # 28 — 29-03-2020

Linear Regulators





$I_L = 100\,mA$

$\eta = 1/5$

$\eta = 3.3/5$

$\eta = 1.8/5$

$$V_{fb} = \frac{R_2}{R_1+R_2} VDD_{OUT} = V_{ref}$$

Power delivered to load, $P_L = VDD_{OUT} \times I_L$ ✓

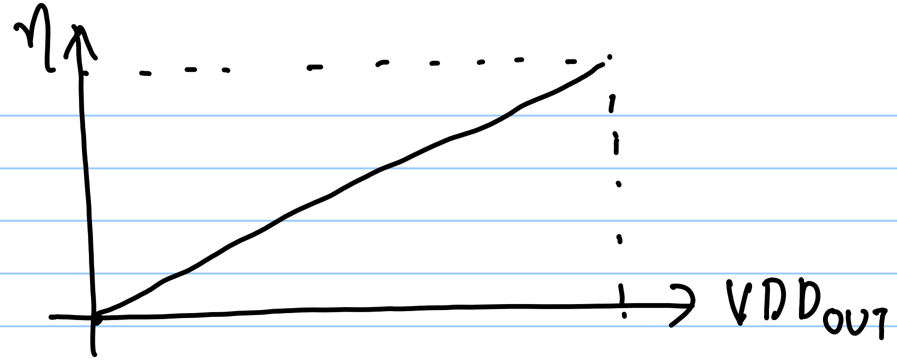
Power drawn from supply, $P_S \geq VDD \times I_L$ ✓

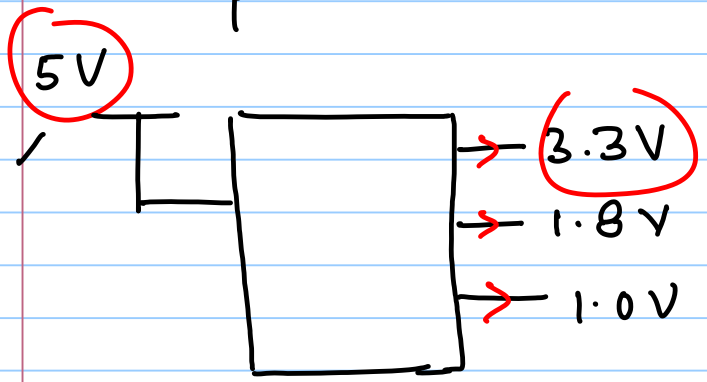
$$\text{Efficiency}, \eta = \frac{VDD_{OUT}}{VDD} \times 100$$

if $VDD_{OUT} \approx VDD$, $\eta \to 100\%$

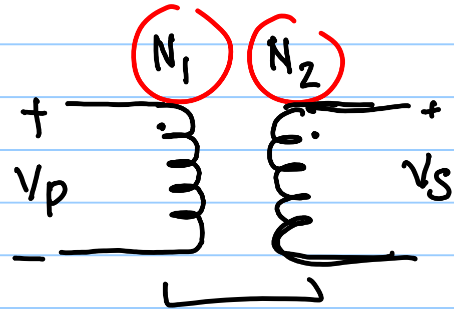
if $VDD_{OUT} < VDD$, $\eta < 100\%$

if V_{drop} is max. $\Rightarrow$ Efficiency is minimum.





Power Conversion to be 100% efficient.

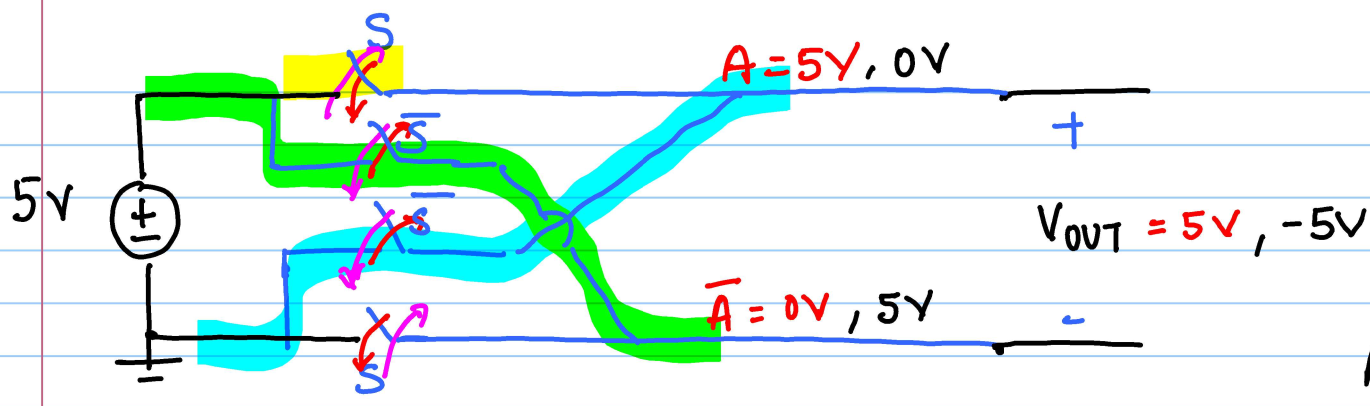


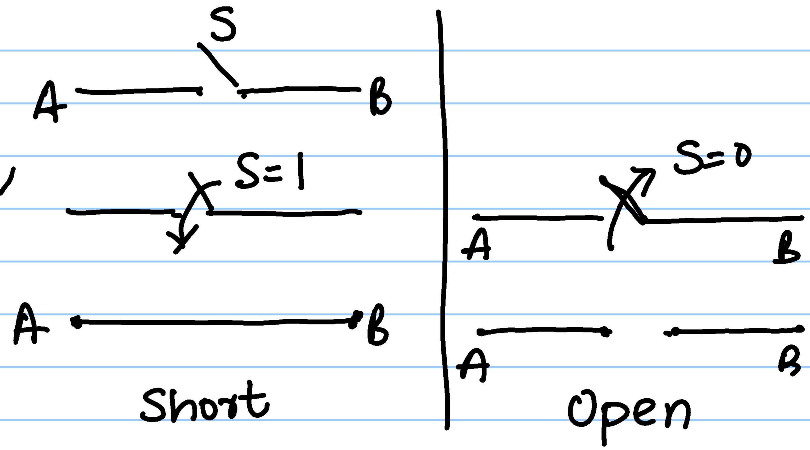
$$\frac{V_p}{V_s} = \frac{N_1}{N_2}$$

- Transformer will help to convert AC voltages.

$DC_1 \longrightarrow AC \longrightarrow AC \longrightarrow DC_2$

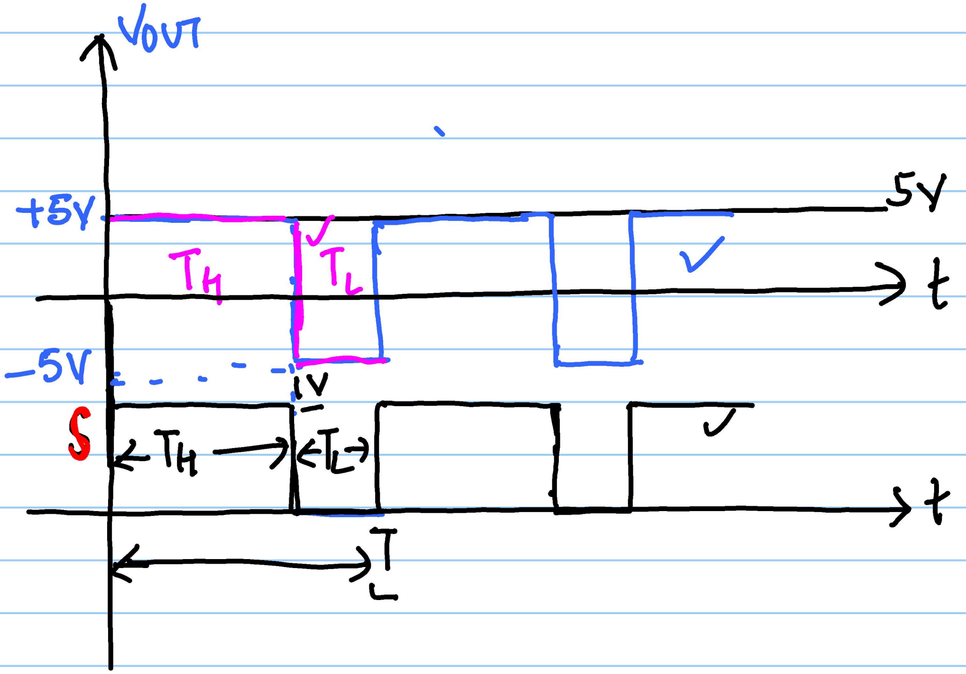
N_1 N_2





$S = 1, 0$

$\bar{S} = 0, 1$



$$V_{OUT}(t) = \sum C_n \sin(n\omega_0 t + \phi_n)$$

$$n\omega_0 = \frac{2\pi}{T} \times n$$

$$V_{out}(t) = \sum a_n \cos(n\omega_0 t) + b_n \sin(n\omega_0 t)$$

$$V_{out,dc} = \frac{T_H \cdot VDD - T_L \cdot VDD}{T_H + T_L}$$

$$V_{out,dc} = VDD\left(\frac{T_H - T_L}{T}\right)$$

$$= VDD\left(\frac{T_H - (T - T_H)}{T}\right)$$

$$= VDD\left(\frac{2T_H}{T} - 1\right)$$

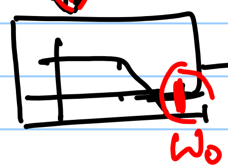
$$= VDD\,(2 \cdot D - 1)$$

D : Duty Cycle of Signal S.

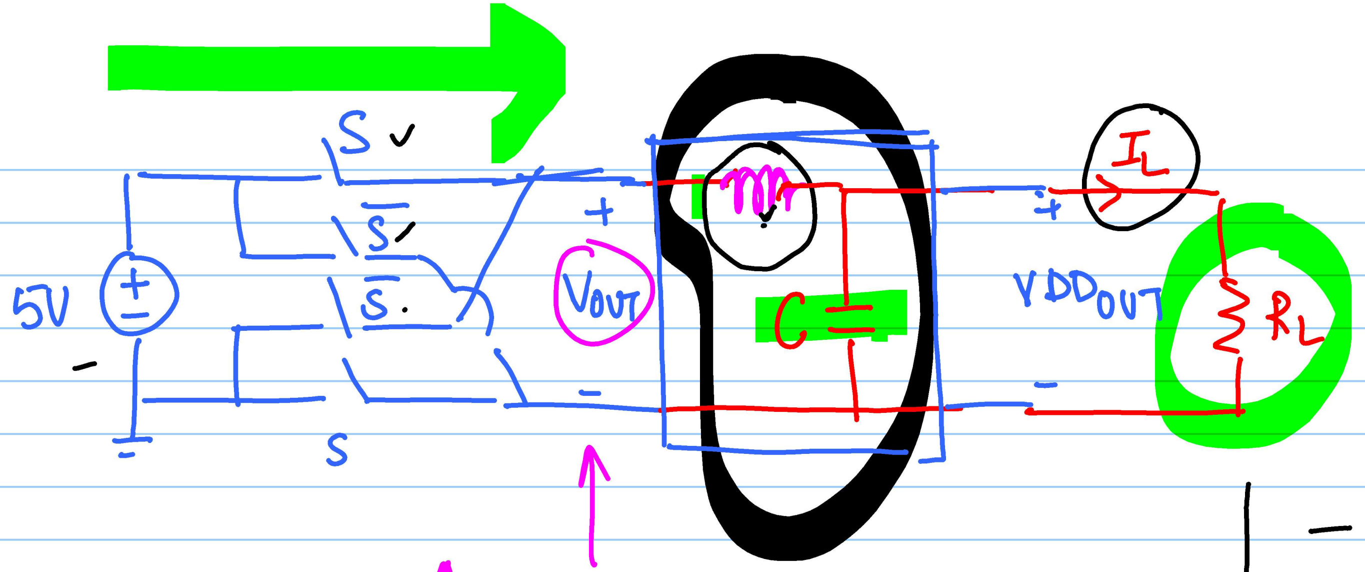
T_H/T	$V_{out,dc}$
0.5	0
0.9	0.8 VDD
0.1	-0.8 VDD

Ideal: DC → AC_1 $\xrightarrow{3\varepsilon}$ AC → DC

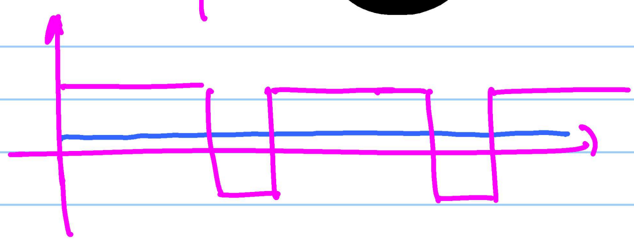
Idea 2: DC → AC_1 : DC voltage which can be controlled by controlling the duty cycle of switches.

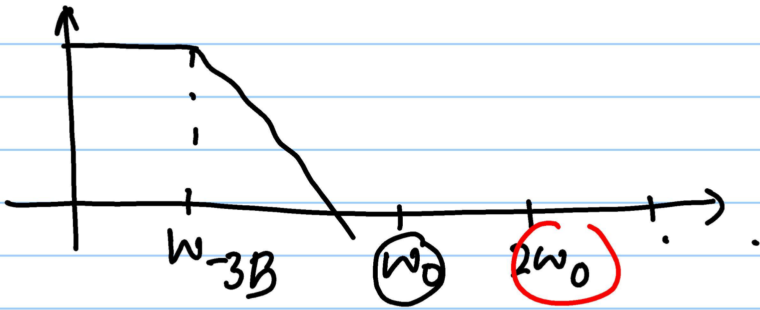


→ DC voltage = VDD (2D − 1)



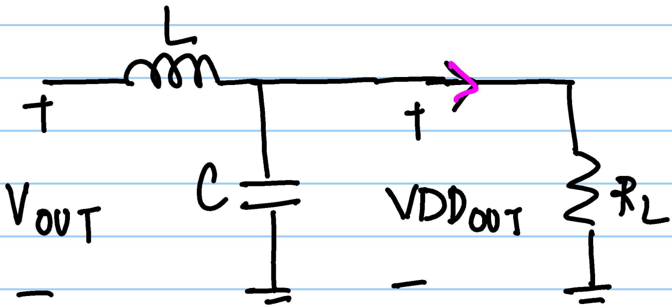
$\eta < 100\%$



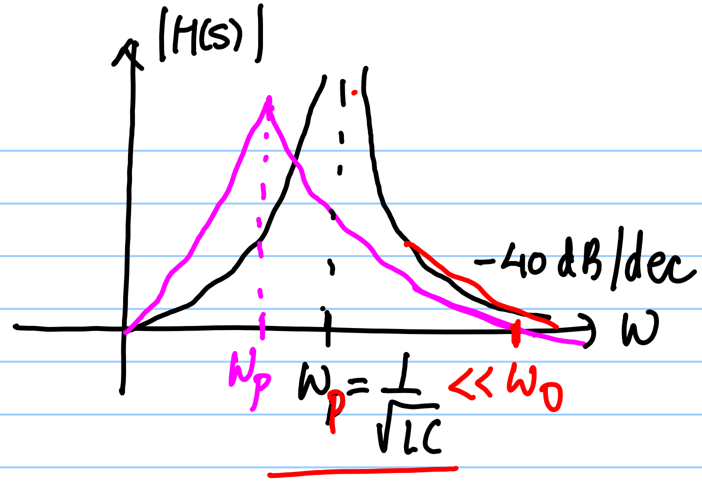


$$w_{-3dB} = \frac{1}{\downarrow RC \uparrow}$$

- Resistor
- Capacitor
- Inductor



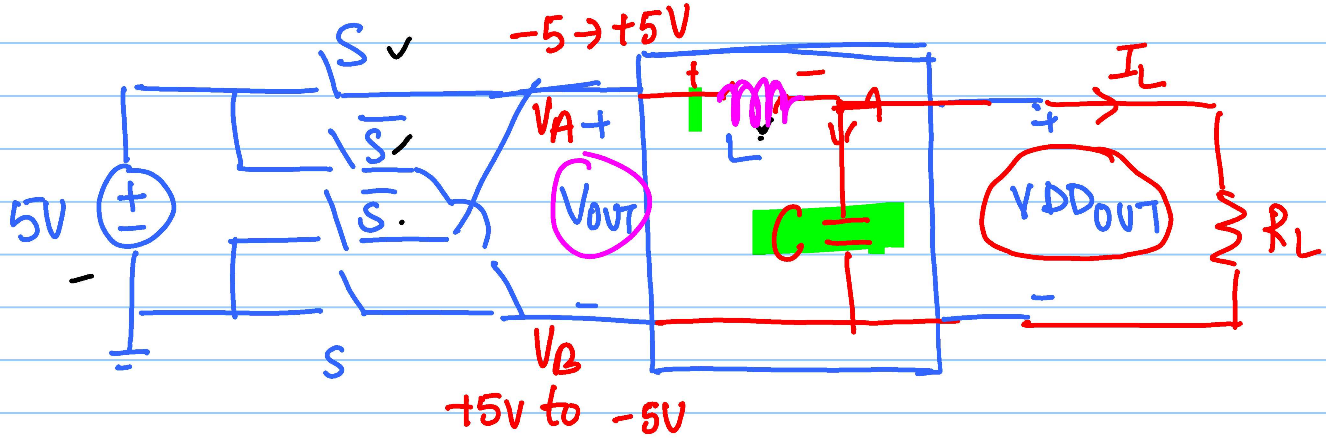
$$H = \frac{V_{DD_{OUT}}}{V_{OUT}} = \frac{1}{1+s^2LC}$$



at very high freq.

$$H \approx \frac{1}{s^2LC}$$

$$H = \frac{V_{DD_{OUT}}}{V_{DD}} = \frac{1}{1+s\frac{L}{R_L}+s^2LC}$$



- VDD_{OUT} is only dc voltage with value $VDD\,(2 \cdot D - 1)$
- D is duty cycle of signal applied to S. S is periodic with period T.
- for LC filter $\frac{1}{\sqrt{LC}} \ll \frac{2\pi}{T} = \omega_0$