Lecture #2 10/1/2021

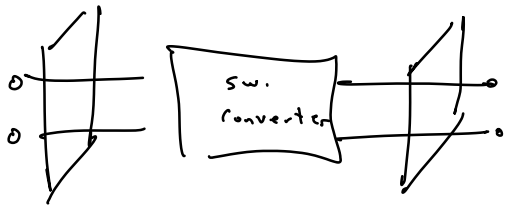
Logistics

- PLECS -> Install using license codes
  - Brian sent today
    - tailored for switching converters

Today

- Motor modeling handout } for lab #1
  - OR
- Power Electronics Ch 1, basics

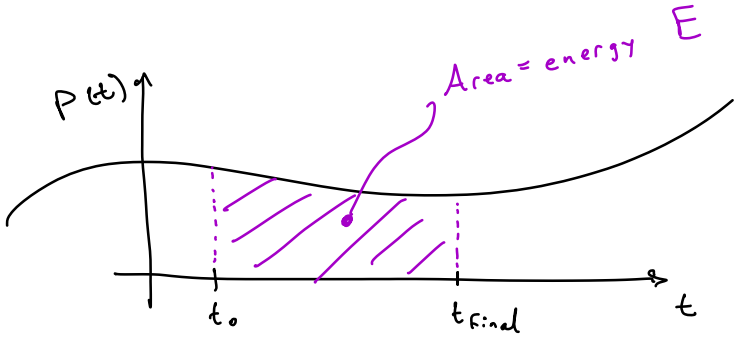
– Energy & Power, physics recap



diff between P & E ?

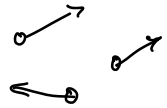
$$P = \frac{dE}{dt} = \text{rate at which energy flows}$$

$$E(t) = \int_{\tau = t_0}^{\tau = t_{final}} P(\tau)\, d\tau$$



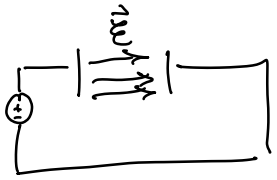
– Forms of Energy

- Kinetic Energy



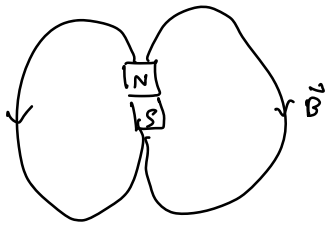
$E = \frac{1}{2} M v^2$

- Electric Field



$E = \frac{1}{2} \varepsilon \vec{\mathcal{E}}^2 \times \text{volume}$

- Magnetic Field



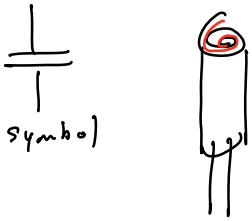
$E = \frac{1}{2} \frac{\vec{B}^2}{\mu} \times \text{volume}$

Lossy Elements

$P_{loss} = i^2 R$

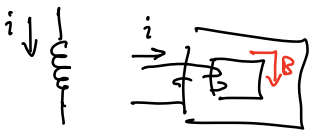
lossy

Capacitor



$E = \frac{1}{2} C v^2$

Inductors

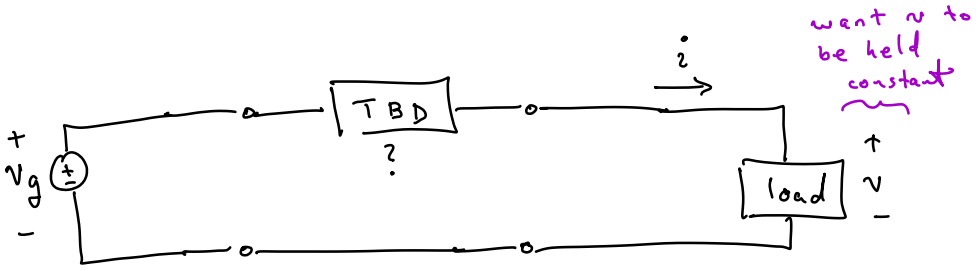


$E = \frac{1}{2} L i^2$

store energy

Transfering Power / Energy w/ ckts

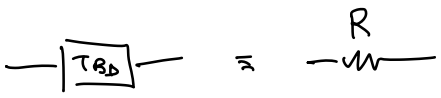
- Naive approach to power transfer



Goal: Regulate v to a target/desired value

where $v \angle v_g$ v_{ref}

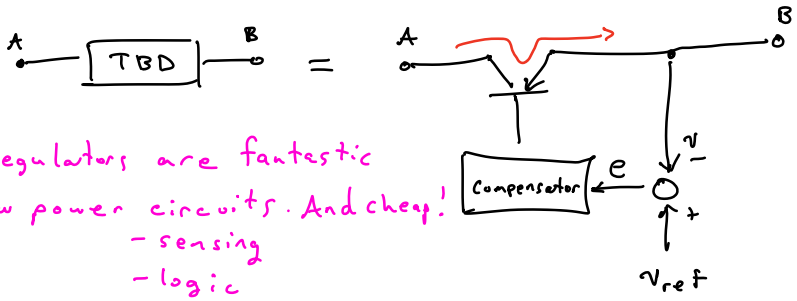
Options. 1) Resistive divider



✗ Only works if load resistance is known & fixed

✗ $P_{loss} = i^2 R$ ← very lossy!

2) Linear regulators (not power electronics)

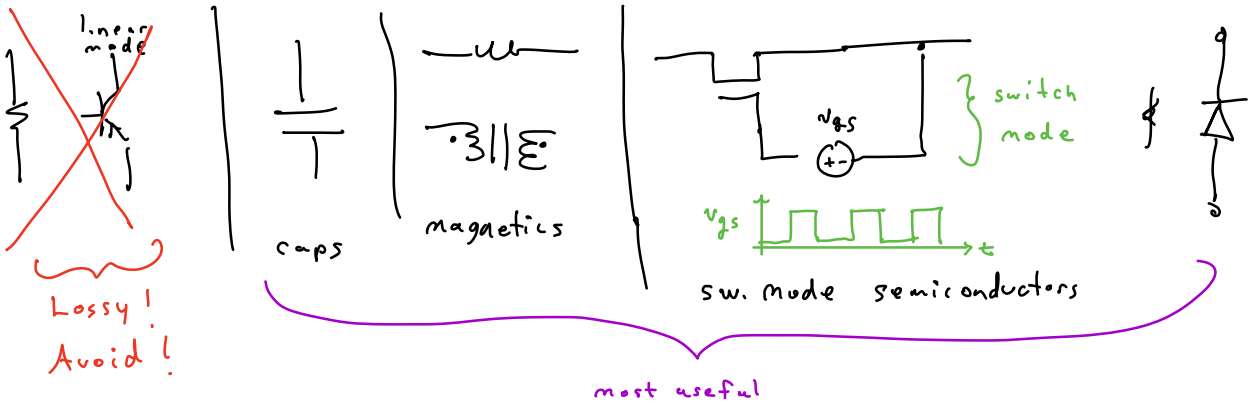


☺ linear regulators are fantastic
For low power circuits. And cheap!
- sensing
- logic

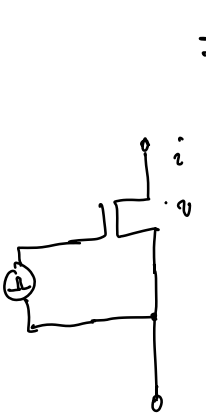
✓ Solves problem of load resistance being unknown.
Behaves as a self-tuning resistor

✗ $P_{loss} = (v_g - v)\,i$ ← still lossy!

— What are sw. power converters built from



Why are these items "useful"?



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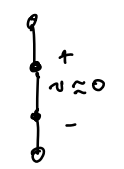
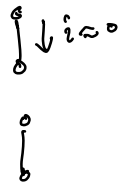


Short ckt
$v \approx 0$

OR



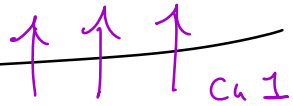
open ckt
$i \approx 0$

Both cases

$P_{loss} = iv$ = zero !

Main idea:

- Switches, which are (ideally) lossless, route power to L's & C's which store energy.
- Periodic switching action passes energy from input to output.



Look Ahead:

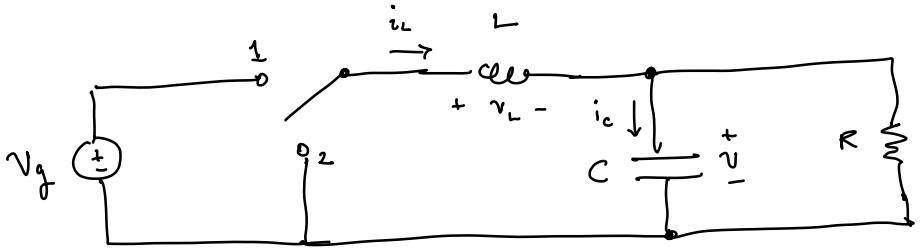
- Spend a few lectures on ch 2
  - → Steady state analysis

* To do: Read Ch 2 over next 1 week.

Chapter 2

Consider the "Buck" converter

↑ step-down



A comment on polarity / sign conventions for analysis

... will continue in Lect # 3