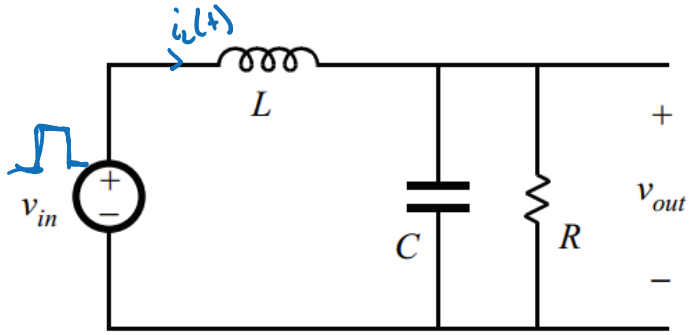
Resonant Circuits



ECE481:

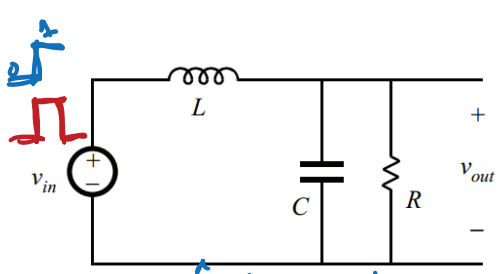
$i_L(t) \approx I_L$
$v_o(t) \approx V$ } ✗ does not generally apply

transient analysis

$$LC\frac{d^2 v_{out}}{dt^2} + \frac{L}{R}\frac{dv_{out}}{dt} + (v_{out} - v_{in}) = \emptyset$$

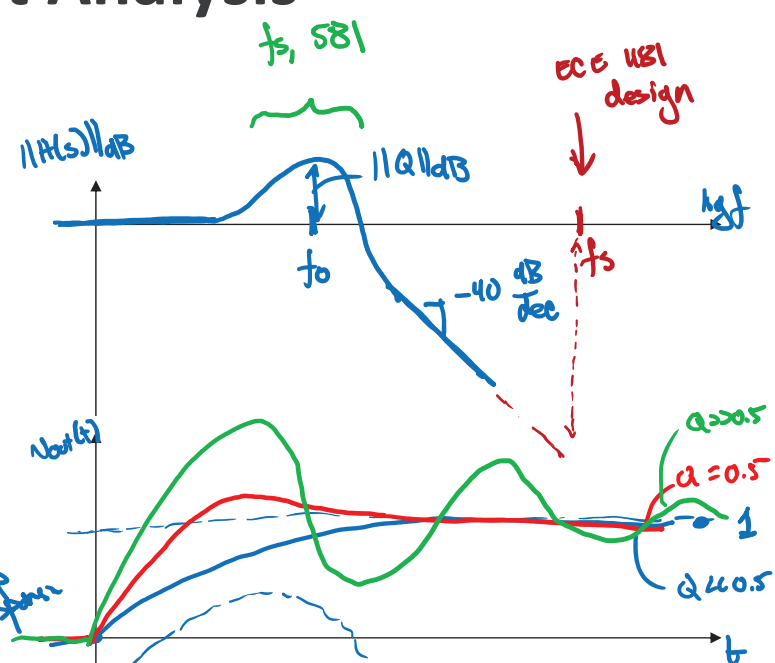
(will develop new techniques in class)

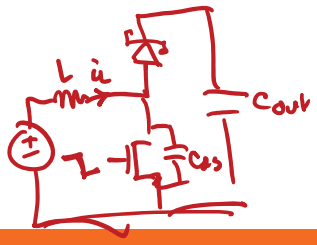
Resonant Circuit Analysis

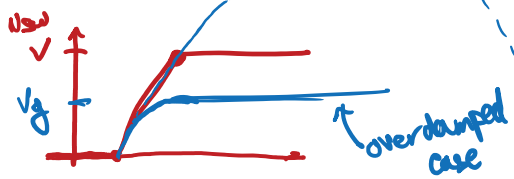


$$\|H(s)\| = \frac{\hat{v}_{out}}{\hat{v}_{in}} = \frac{1}{s^2LC + s\frac{L}{R} + 1}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} \qquad R_0 = \sqrt{\frac{L}{R}} \qquad Q = \frac{R}{R_0}$$



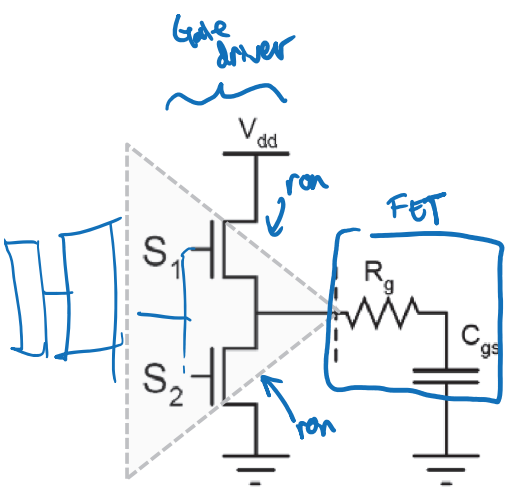




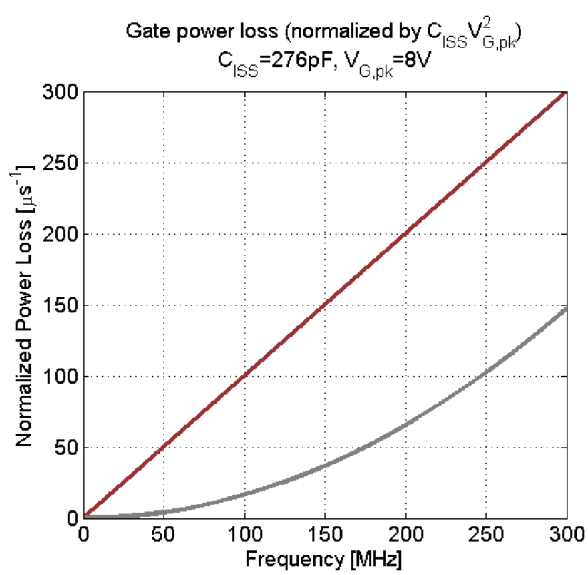
Soft Switching

- Advantages
  - Reduced switching loss
  - Possible operation at higher switching frequency
  - Lower EMI
- Disadvantages
  - Increased current and/or voltage stresses due to circulating current
  - Higher peak and rms current values
  - Complexity of analysis and modeling

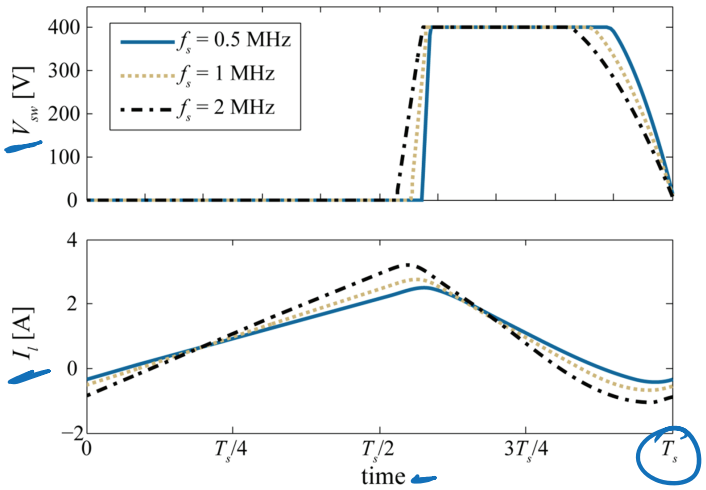
Limitations: Gate Drive



$P_g = E_g f_s$

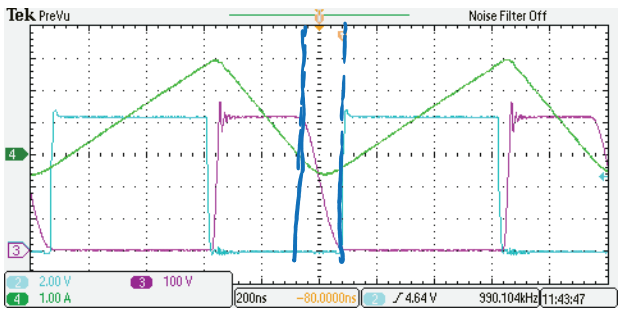


Limitations: t_d/T_s

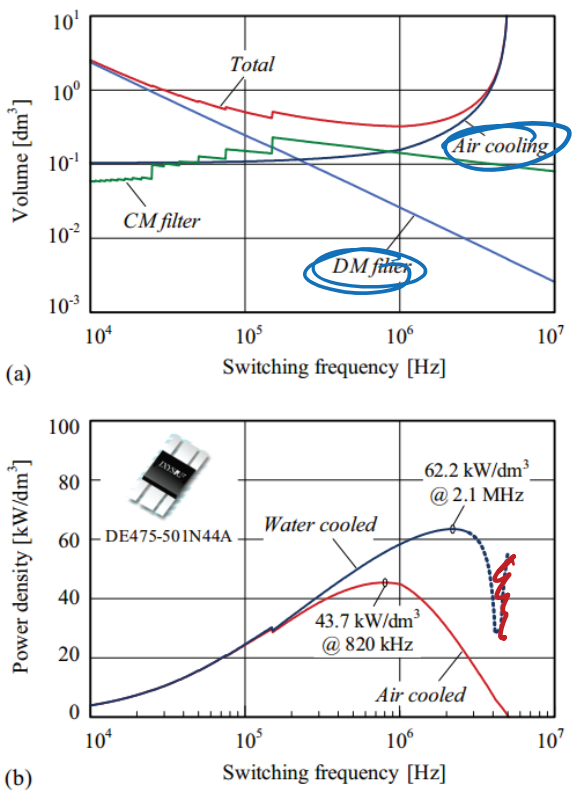


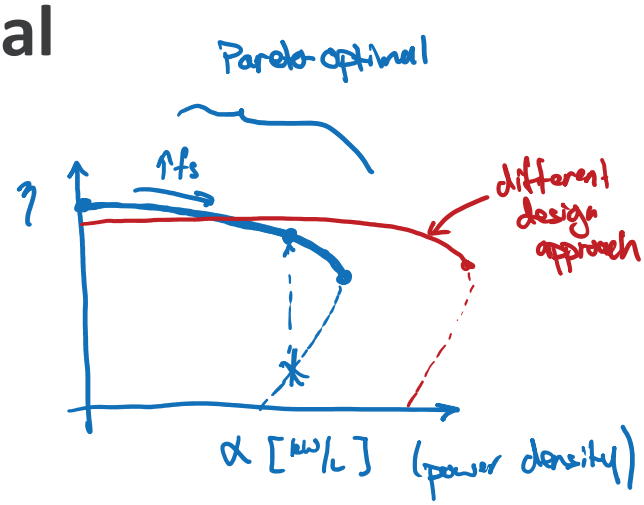
as $f_s \uparrow$

$\frac{t_d}{T_s} \uparrow \rightarrow i_{L,pk} \uparrow$



Limitations: Thermal





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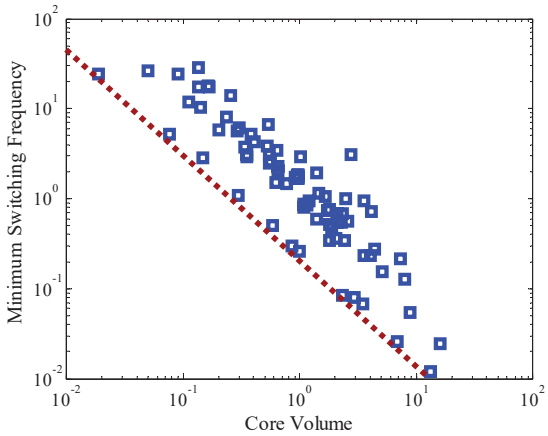
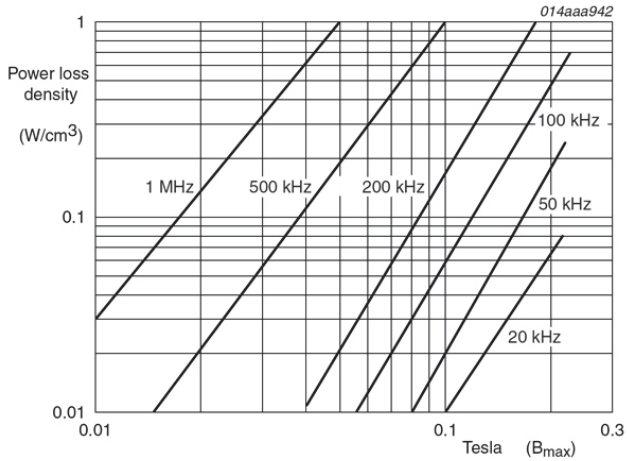
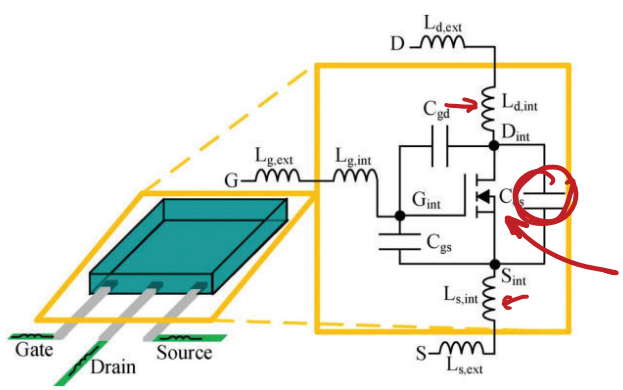
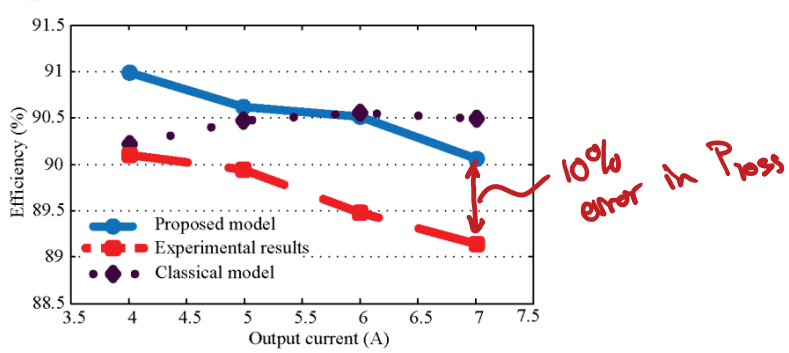
Limitations: Magnetics Design





Limitations: Circuit Modeling





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