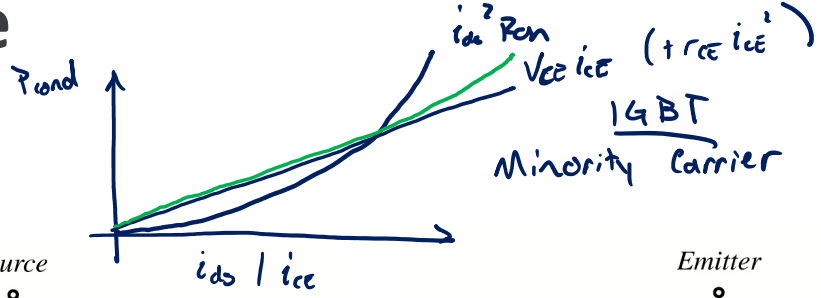
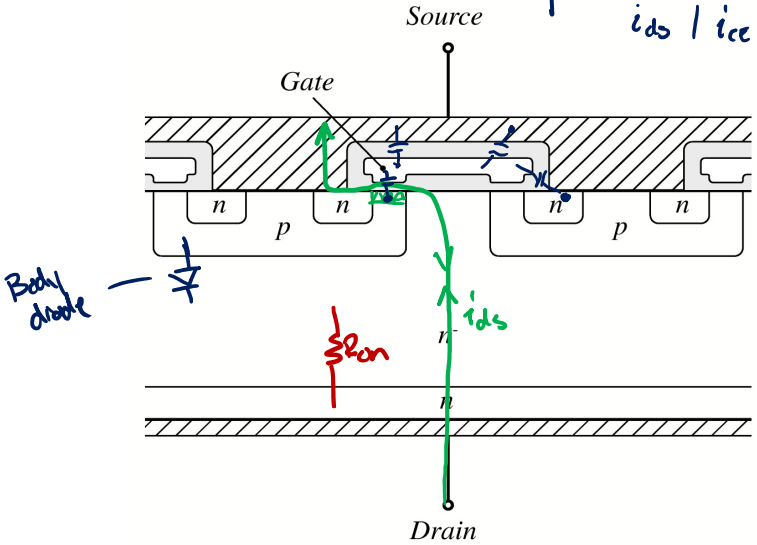
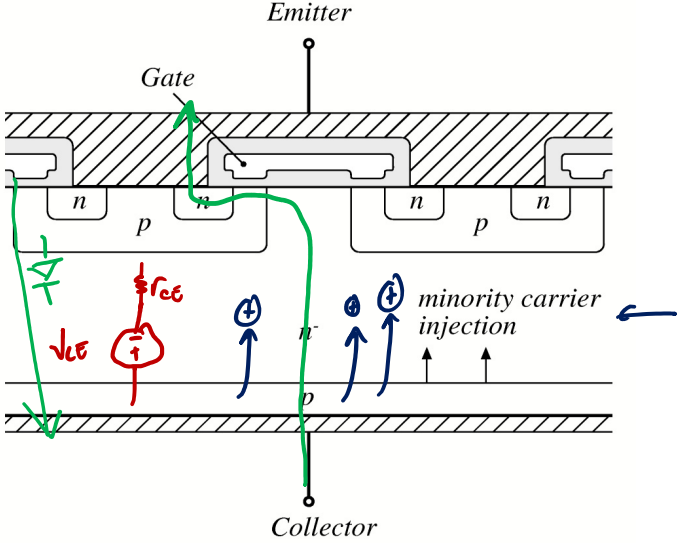
Charge Storage



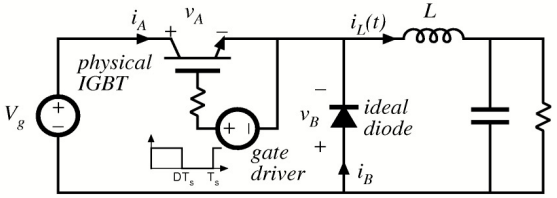




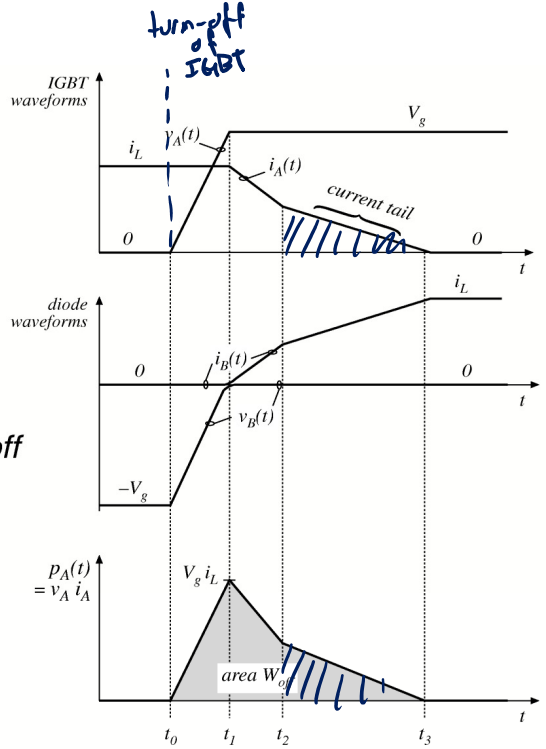
- R_{on} fixed by doping density
+ No stored minority charge

+ Conductivity Modulation
- Stored minority charge

IGBT Current Tailing



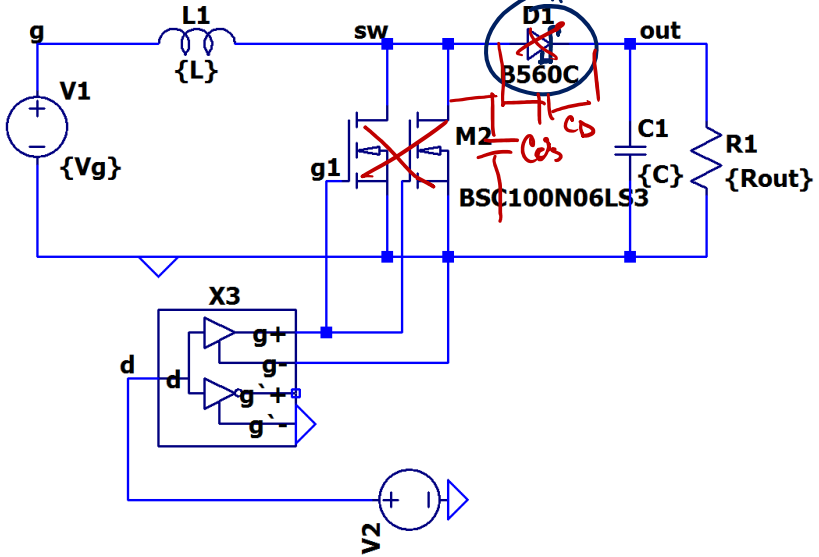
Example: buck converter with IGBT



transistor turn-off transition

$$P_{sw} = \frac{1}{T_s} \int_{\substack{\text{switching} \\ \text{transitions}}} p_A(t)\, dt = (W_{on} + W_{off})\, f_s$$

Schottky Diode



Schottky Diode → Majority Carrier Diode

ohmic contact

Schottky contact

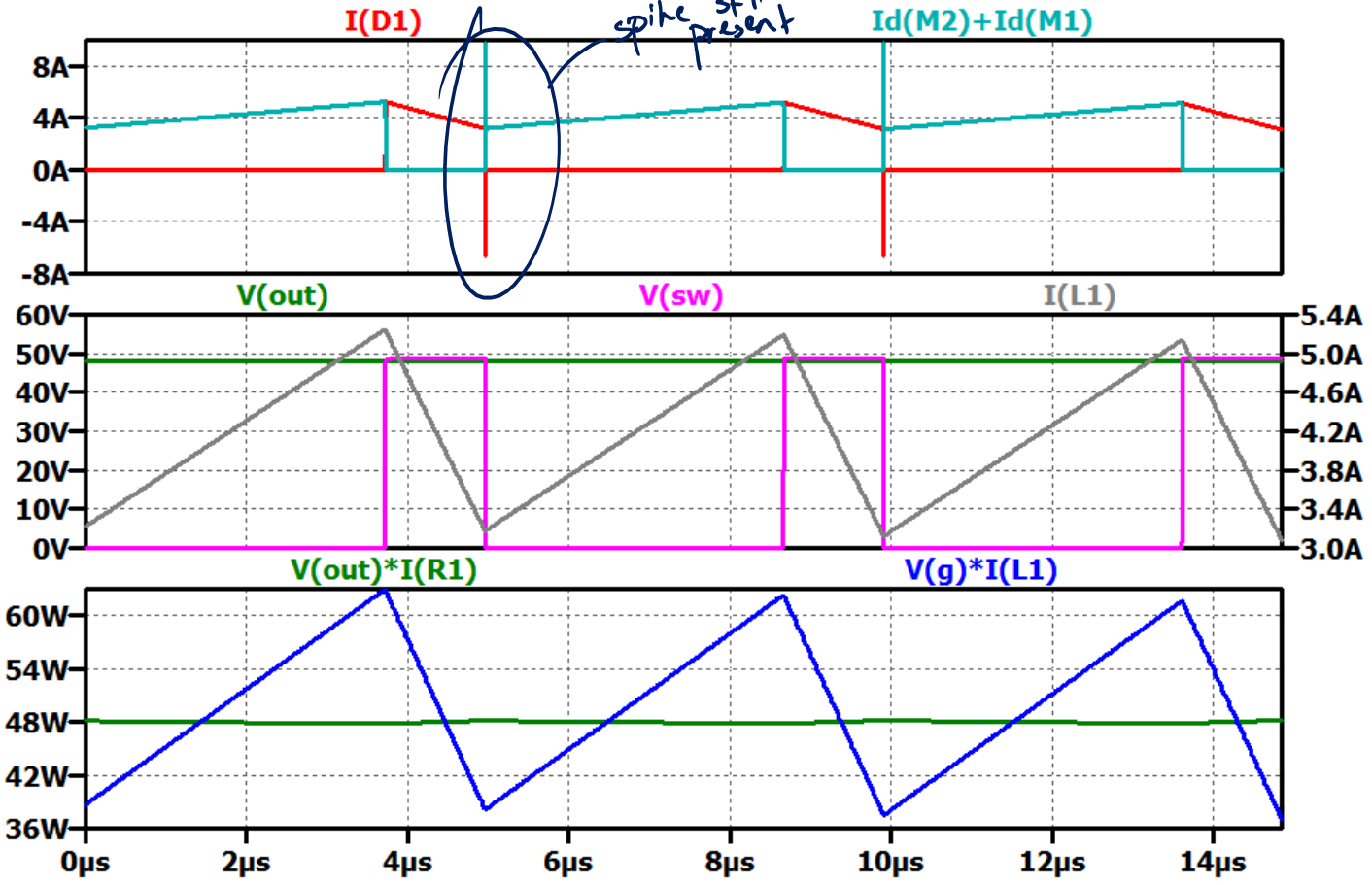
- "No" reverse recovery
- Limited HV performance in Si now, Good SiC HV schottky diodes

L	C_{out}	f_s	Diode	η (Sim)
22uH	22uF	202k	Si (FR)	93.9%
22uH	22uF	202k	Si Schottky	95.8%

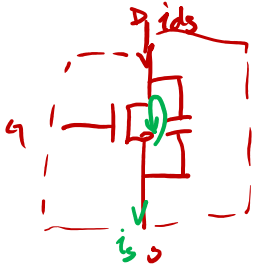
~2% increase in η

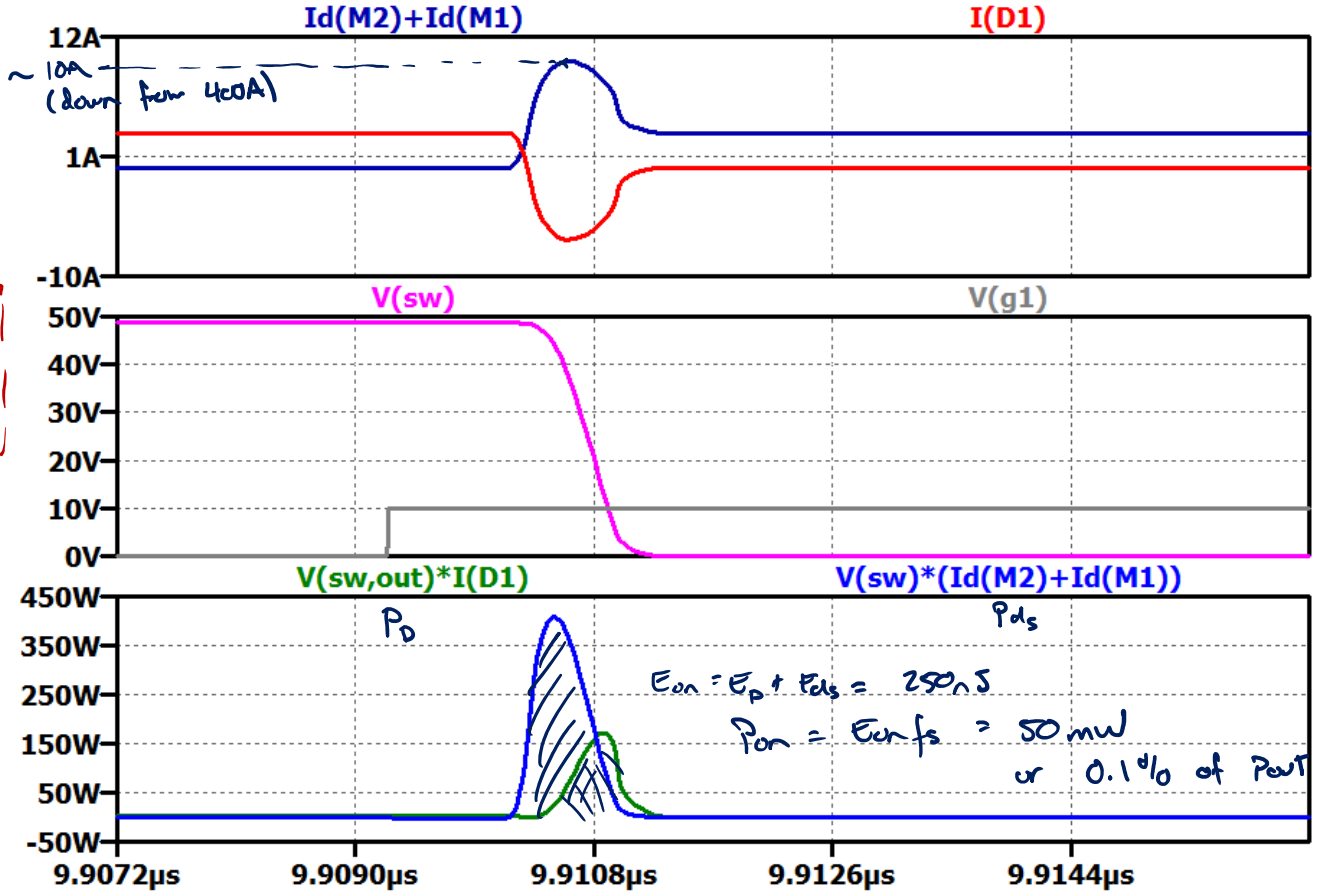
(But was hoping for 3%)

Simulation Waveforms

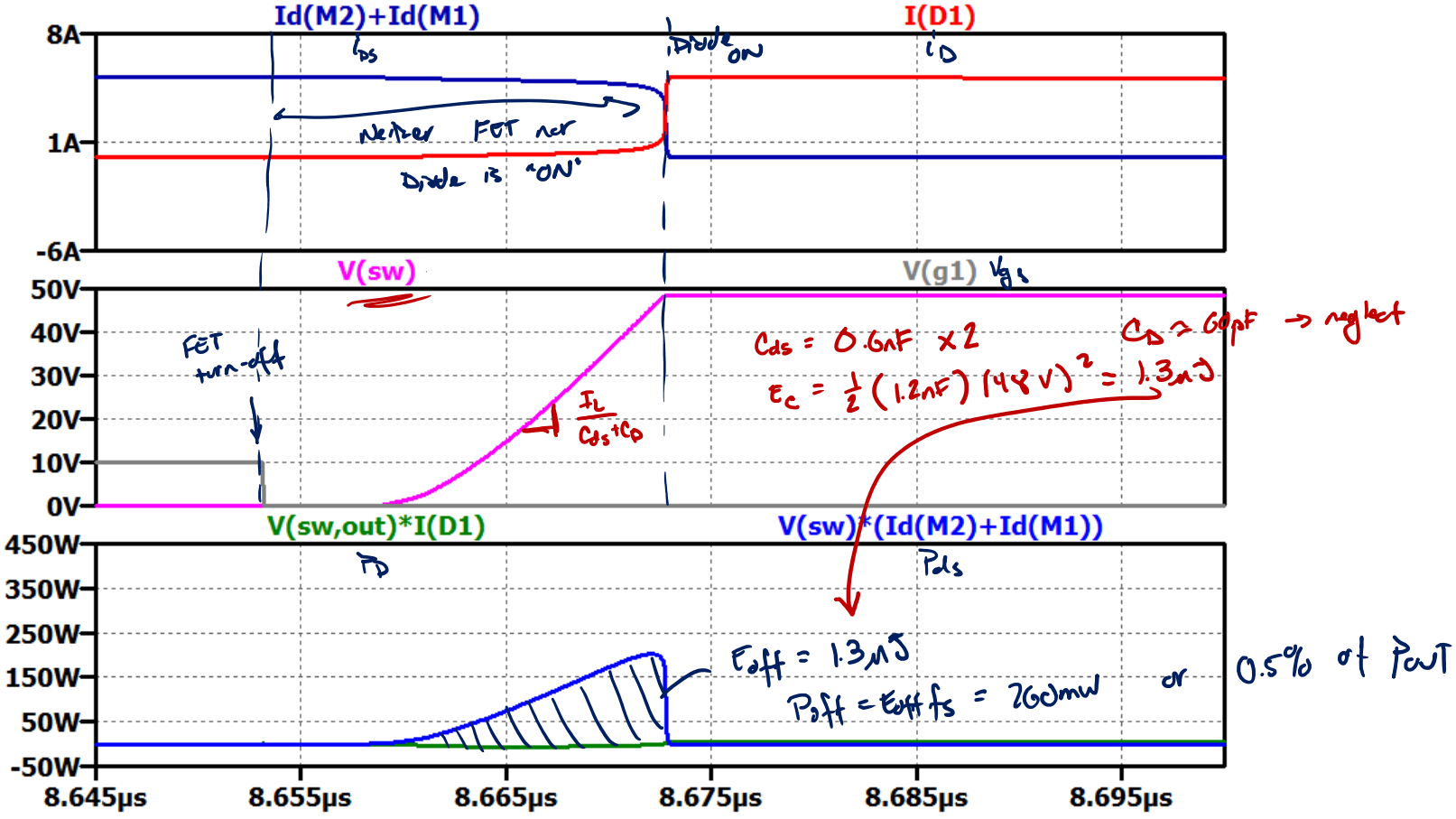


Switching Transition – FET turn ON





Switching Transition – FET turn OFF



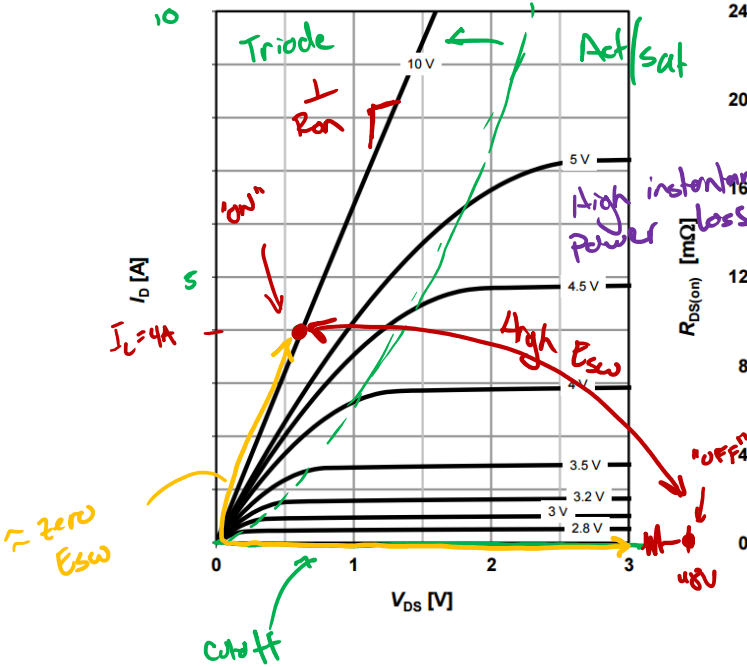
MOSFET Switching Behaviors

First : static

5 Typ. output characteristics

$I_D=f(V_{DS})$; $T_j=25$ °C

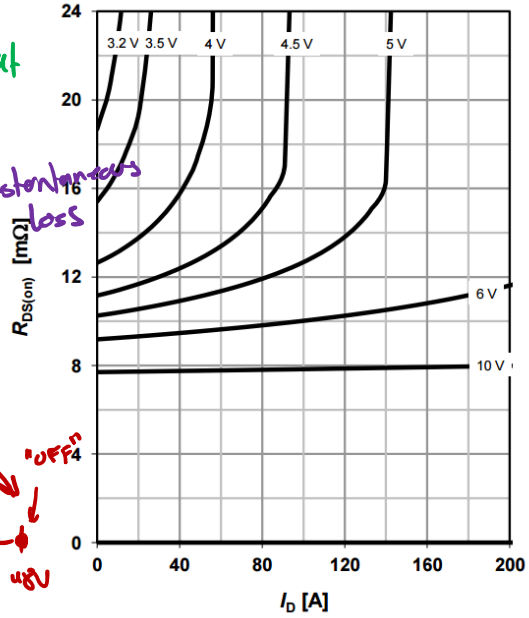
parameter: V_{GS}



6 Typ. drain-source on resistance

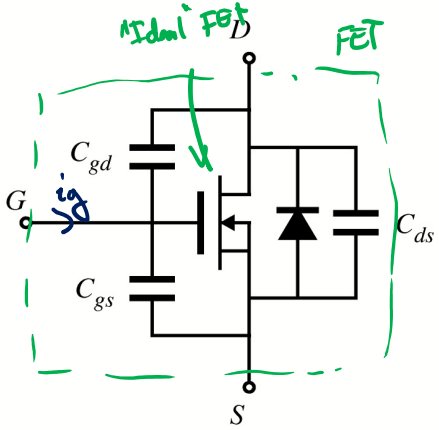
$R_{DS(on)}=f(I_D)$; $T_j=25$ °C

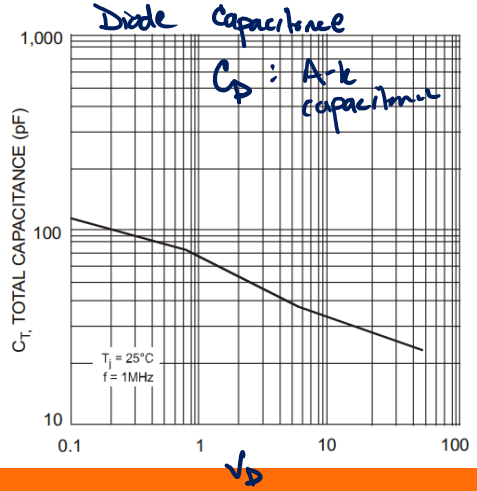
parameter: V_{GS}

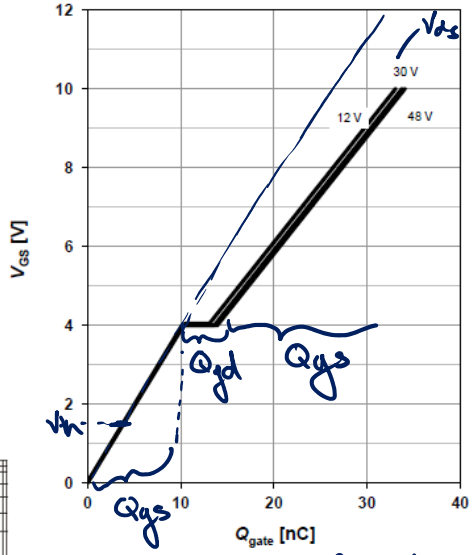


MOSFET Stored Charge

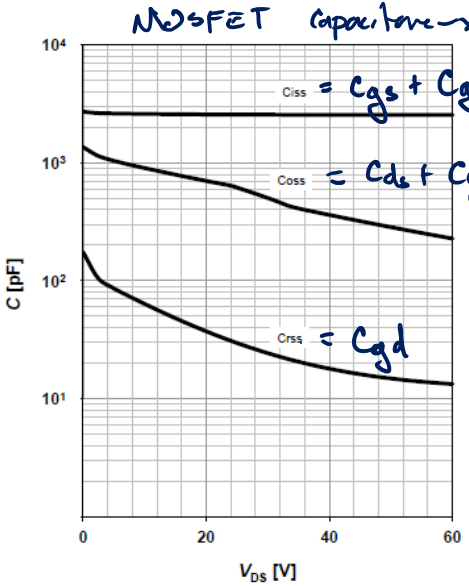
Then: Dynamic







$Q_g = \int i_g \, dt$



$C_{gd} \ll C_{ds} \ll C_{gs}$