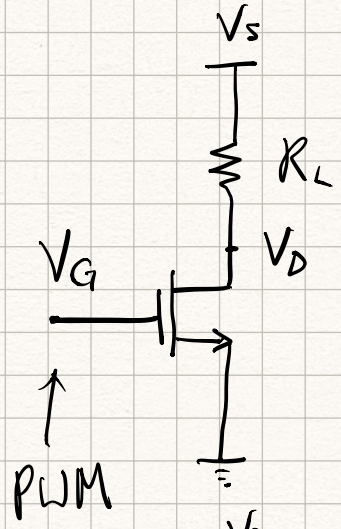
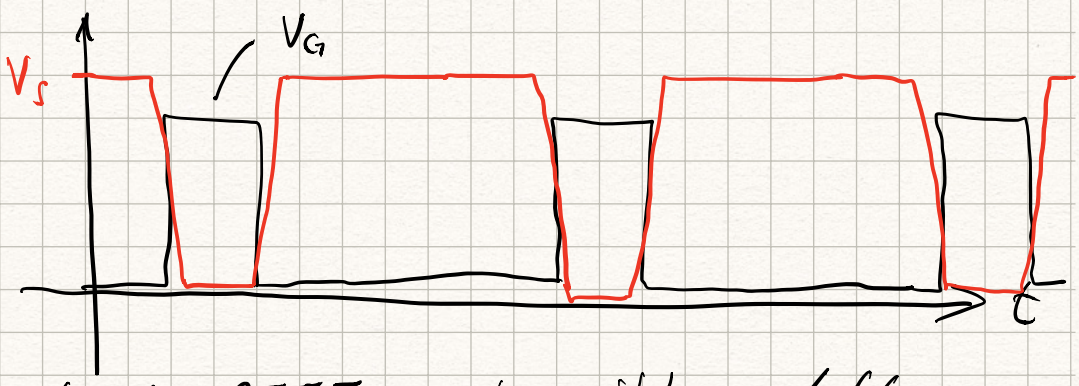
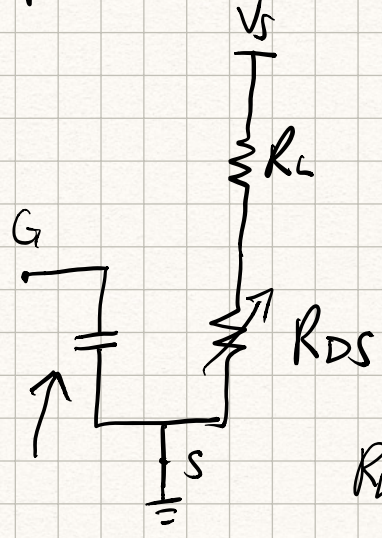
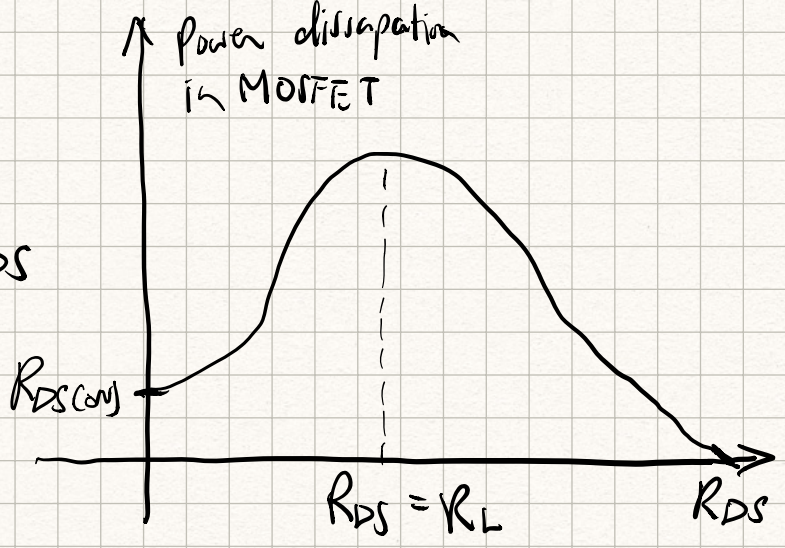
# MECH 421 Lecture 22

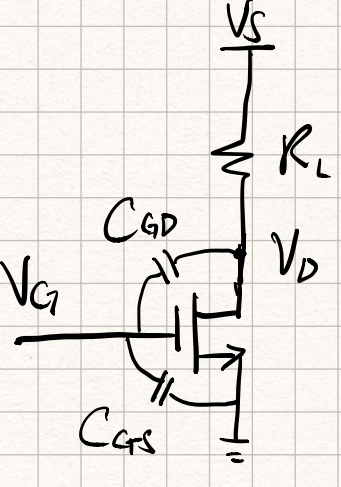



* The MOSFET must switch on/off completely with each PWM cycle.
* The load (e.g. motor) averages the output current.



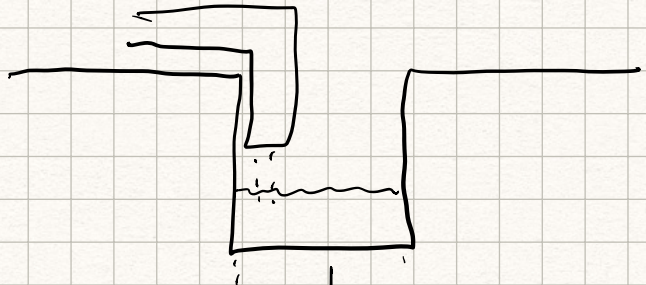

$C_{GS} \gg C_{GD}$

but $C_{GD}$ is magnified because the Miller effect.

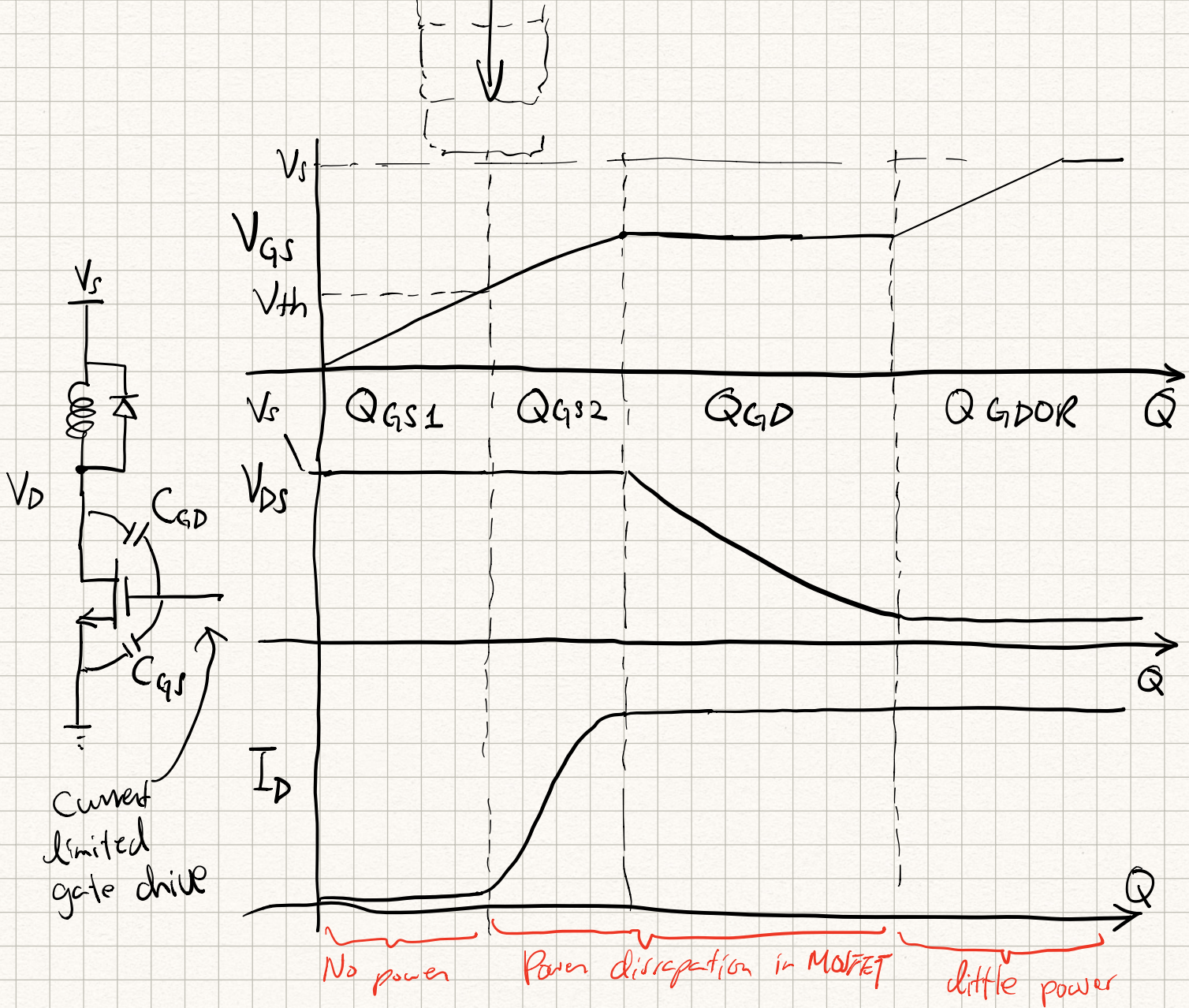
when the MOSFET is off $V_D = V_S$

when the MOSFET turns on

$V_D$ goes from $V_S \rightarrow$ Gnd.



$Q = CV$




## Example MOSFET Power dissipation Calculation

Suppose $Q_{GS2} + Q_{GD} = 10nC$

Drive using a logic gate: $I_G = 10mA$

$$Q = I\Delta t \qquad \Delta t = \frac{Q}{I_G} = \frac{10^{-8}\ C}{10^{-2}\ A} = 10^{-6}\ s$$

$$= 1\mu s$$

PWM system:

$V_s = 12V$

$I_{max} = 5A$

$\Delta t = 10^{-6}\ s$

$T$ — PWM period $= 10^{-4}\ s$

Power from switching

$$P = \frac{2 V_s I_{max} \Delta t}{T}$$

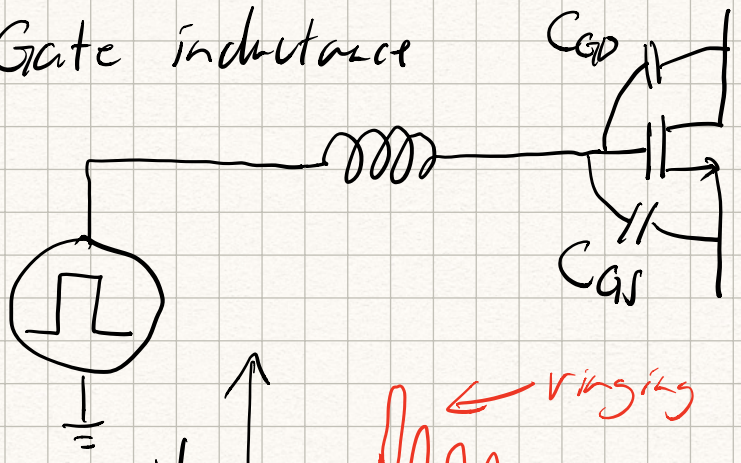
$$P = 2(12V)(5A)(10^{-6}s)/10^{-4}s = 1.2W$$ ← a lot of heat

If you drive MOSFET using a FET driver

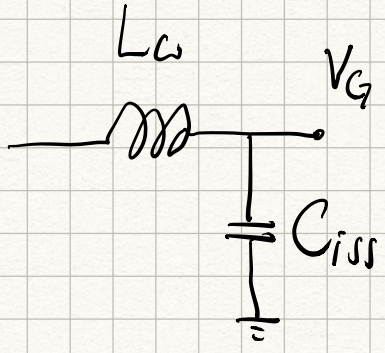
$I_G = 1A$ $\quad P = 12\,mW$

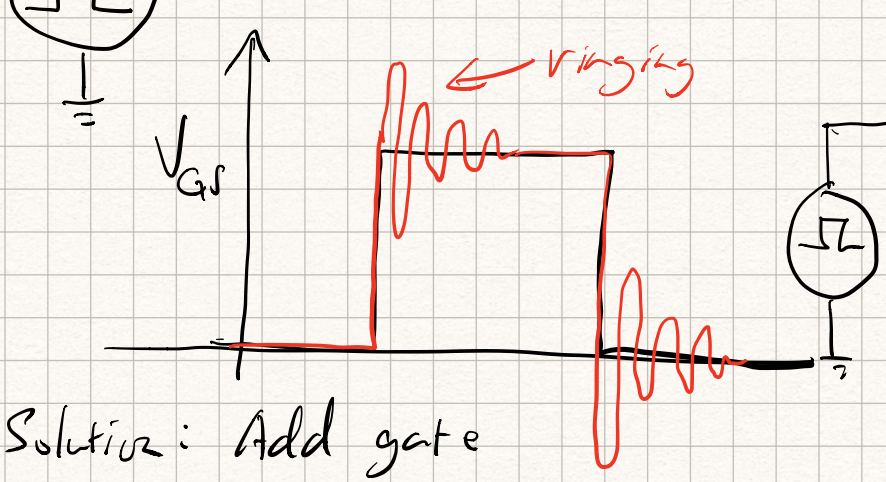
## Practical pitfalls of MOSFETs

Gate inductance




$\Rightarrow$





For critical clamping

$$R_G = 2\sqrt{\frac{L_G}{C_{iss}}}$$

Solution: Add gate resistor

Typically, $R_G = 10 - 100\,\Omega$