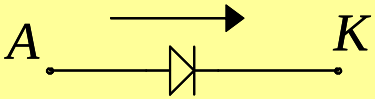
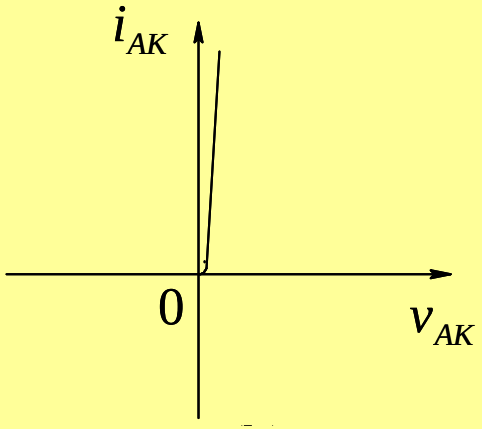
Design of Switching Power-Poles

- Power Semiconductor Devices
  - Diodes
  - Transistors
- Losses in Switching Power-Poles
  - Switching Losses
  - Conduction Losses

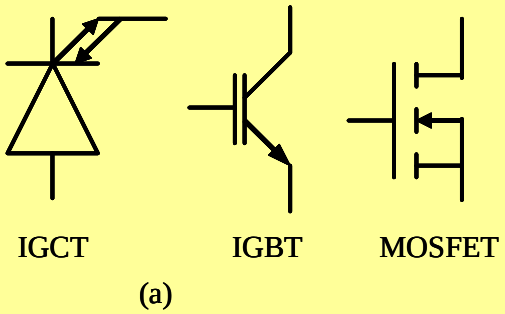
Choice of Diodes



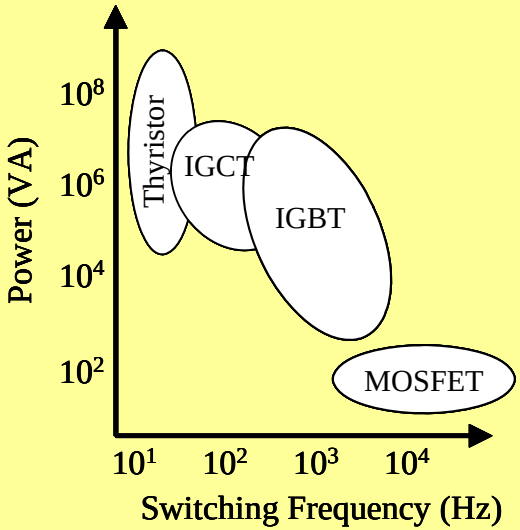


- Line-Frequency Diodes
- Fast Recovery Diodes
- Schottky Diodes

Choice of Power Transistors



(a)

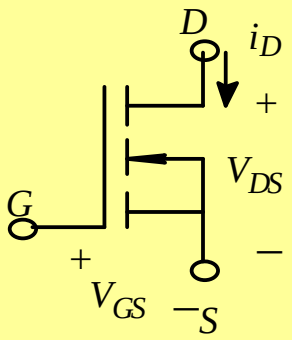


- MOSFET
- IGBT
- IGCT
- GTO
- Others

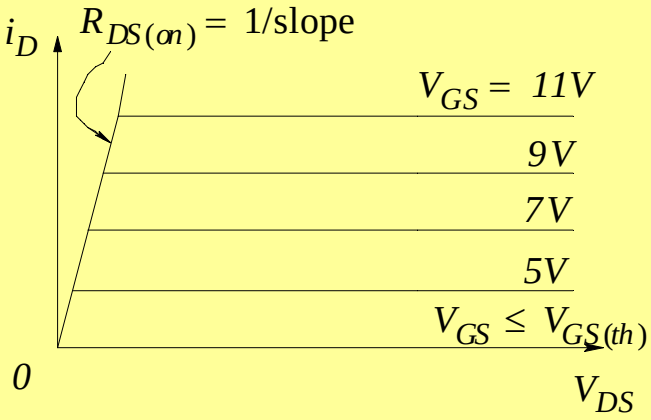
SELECTION OF POWER TRANSISTORS AND POWER DIODES

- Voltage Ratings
- Current Ratings
- Switching Speeds
- On-State Voltage Drop

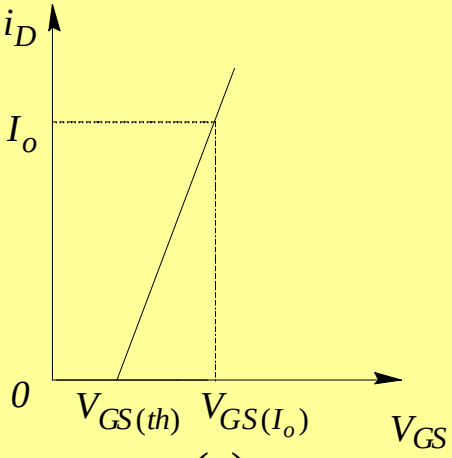
MOSFET Characteristics



(a)



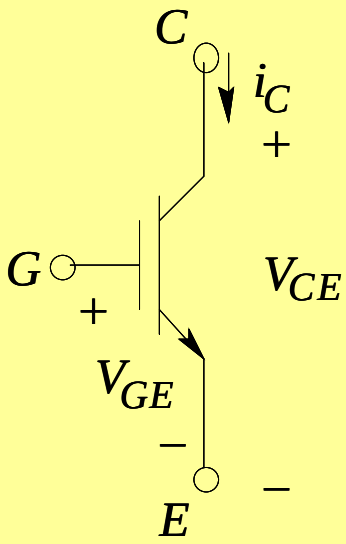
(b)



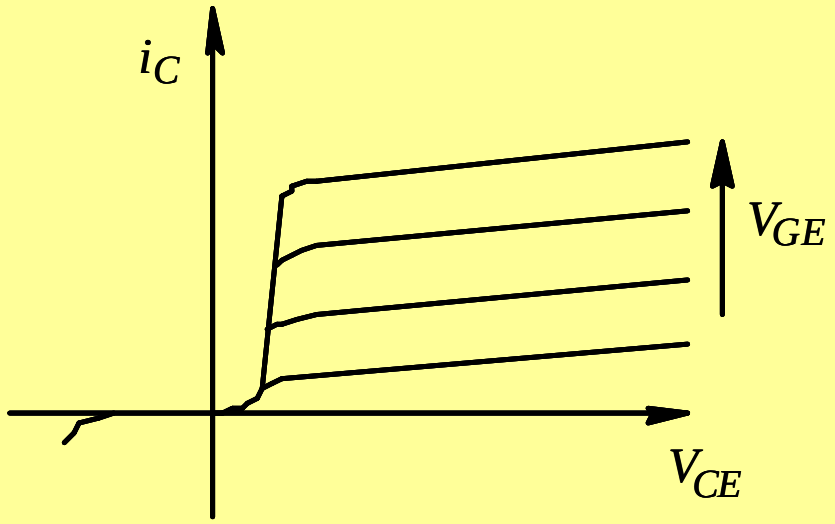
(c)

$$R_{DS(on)} \alpha V_{DSS}^{2.5 to 2.7}$$

IGBT Characteristics

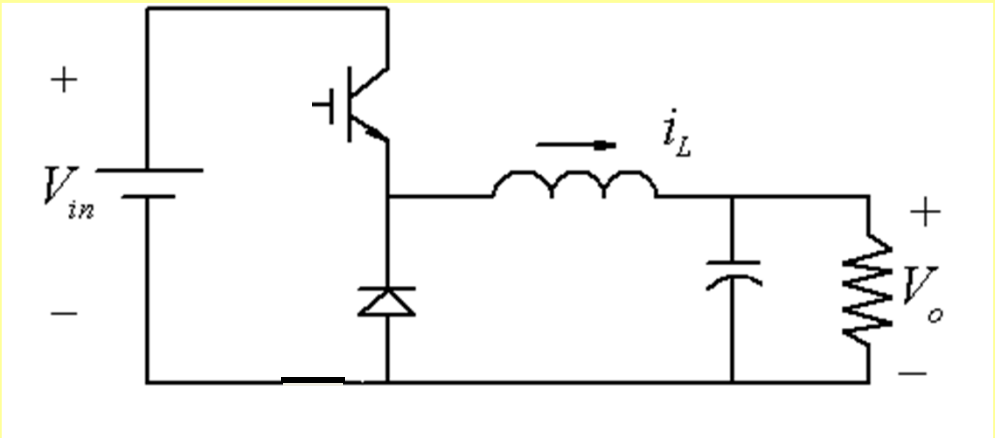


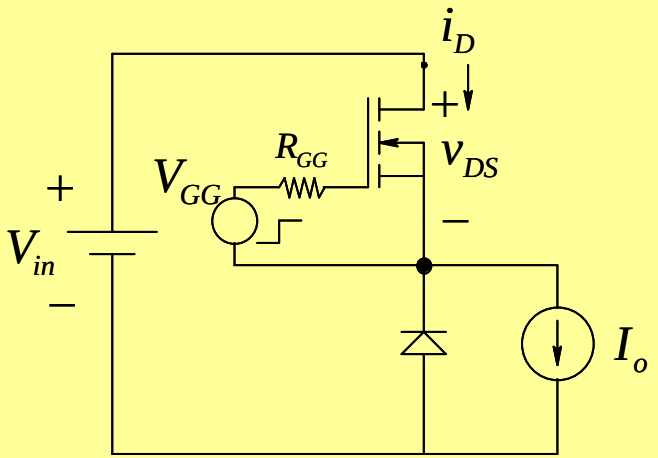
(a)

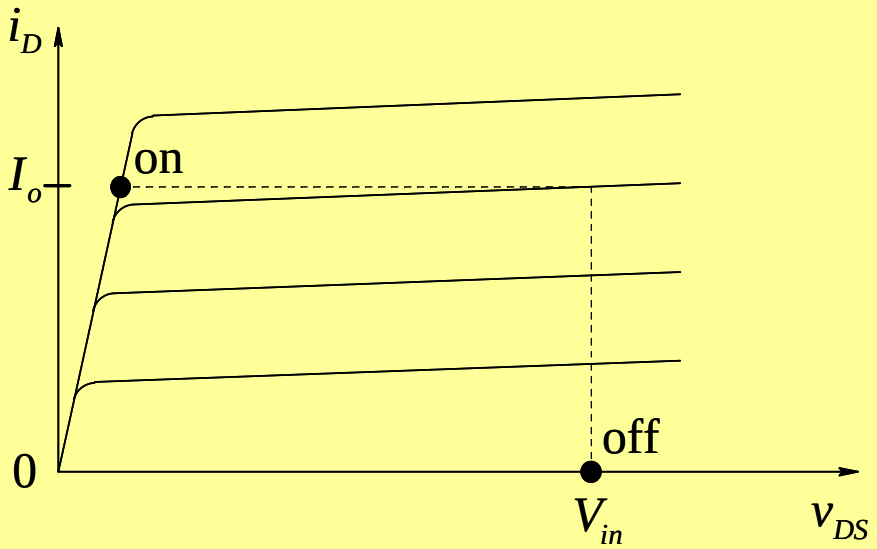


(b)

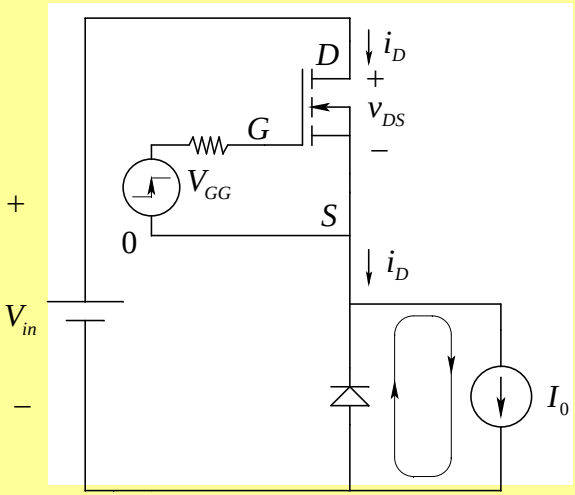
Switching in a Power-Pole

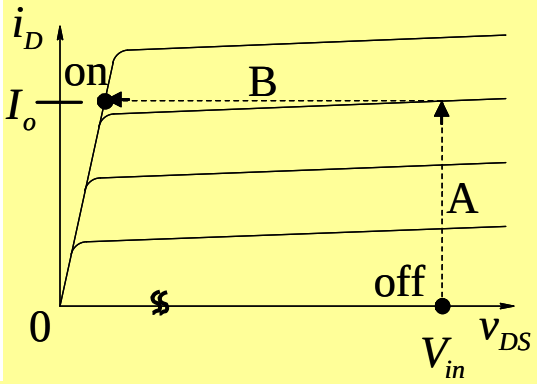


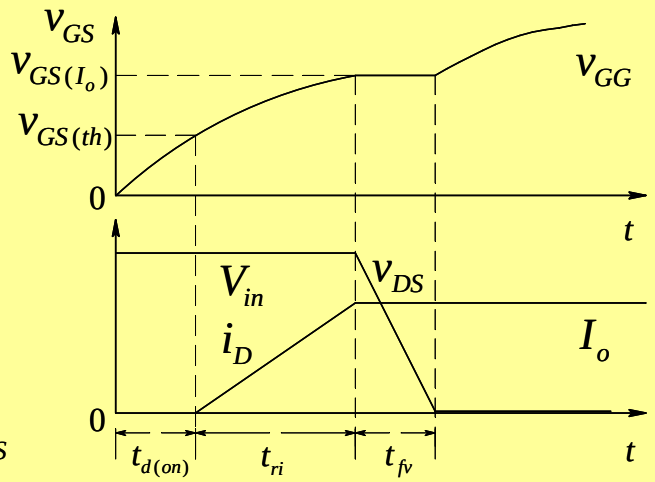




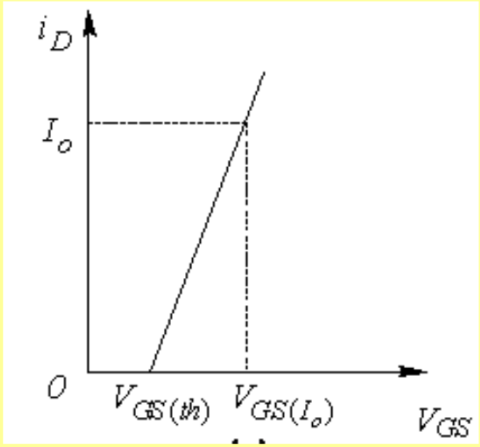
Turn-on Characteristics



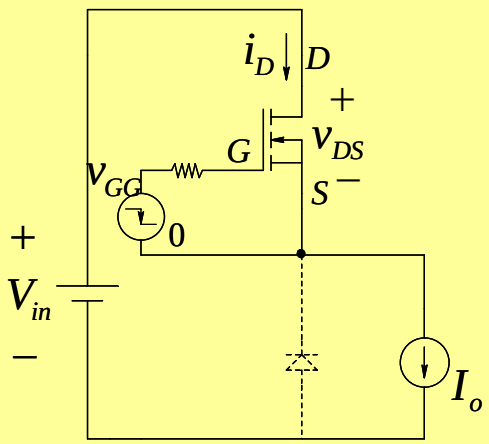


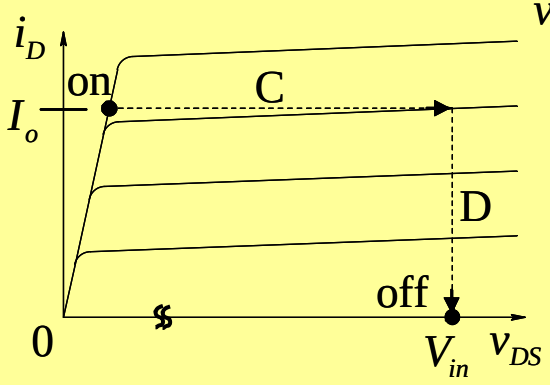


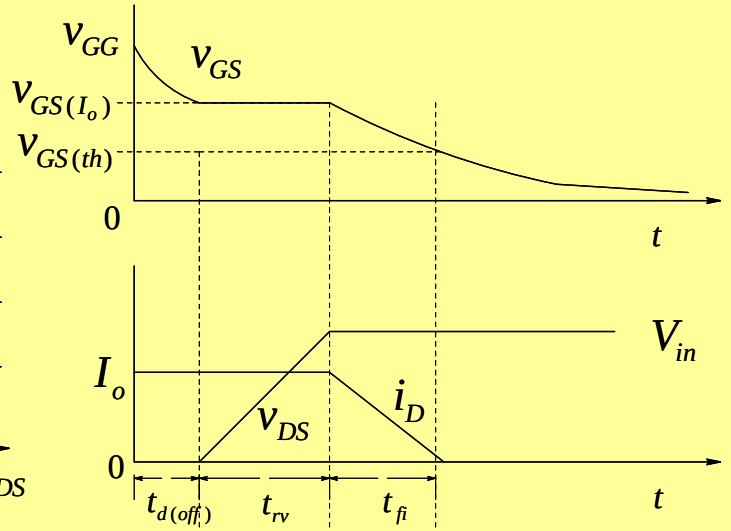
$$i_{diode} = I_o - i_D \quad i_D \le I_o$$

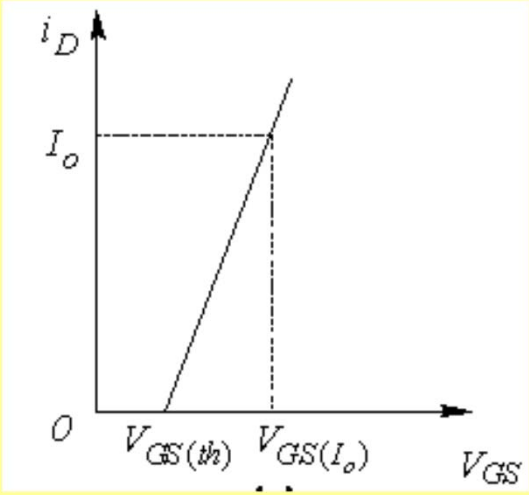


Turn-off Characteristic

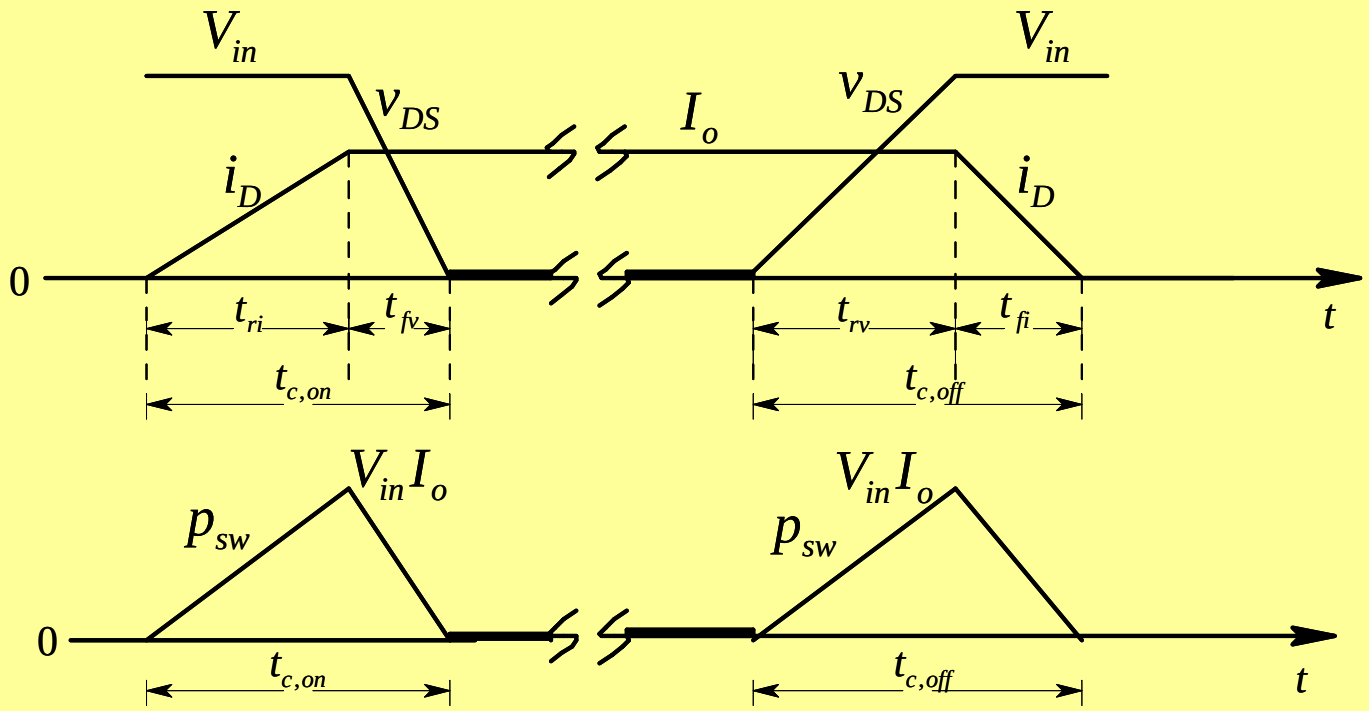








Calculating Power Losses Within the MOSFET (assuming an ideal diode)

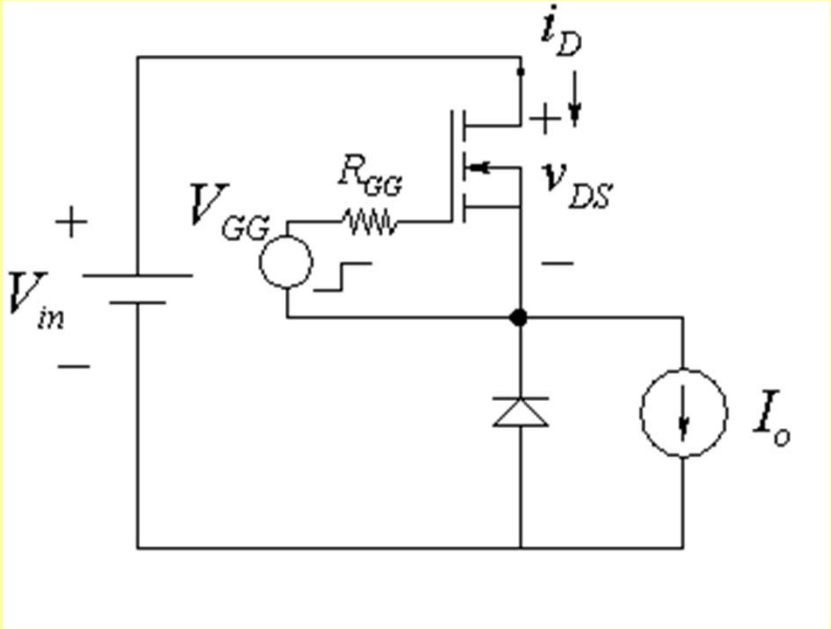


Switching Losses: $$P_{sw} = \frac{1}{2} V_{in} I_o (t_{c,on} + t_{c,off}) f_s$$

$$t_{c,on} = t_{ri} + t_{fv}$$

$$t_{c,off} = t_{rv} + t_{fi}$$

Conduction Loss:



$$P_{cond} = d\left(R_{DS(on)} I_o^2\right)$$

Summary

- Design of a Switching Power-Pole
  - Power Semiconductor Devices
    - Diodes
    - Transistors
  - Losses in Switching Power-Poles
    - Switching Losses
    - Conduction Losses