CMOS Timing Characteristics

Last updated 10/24/24

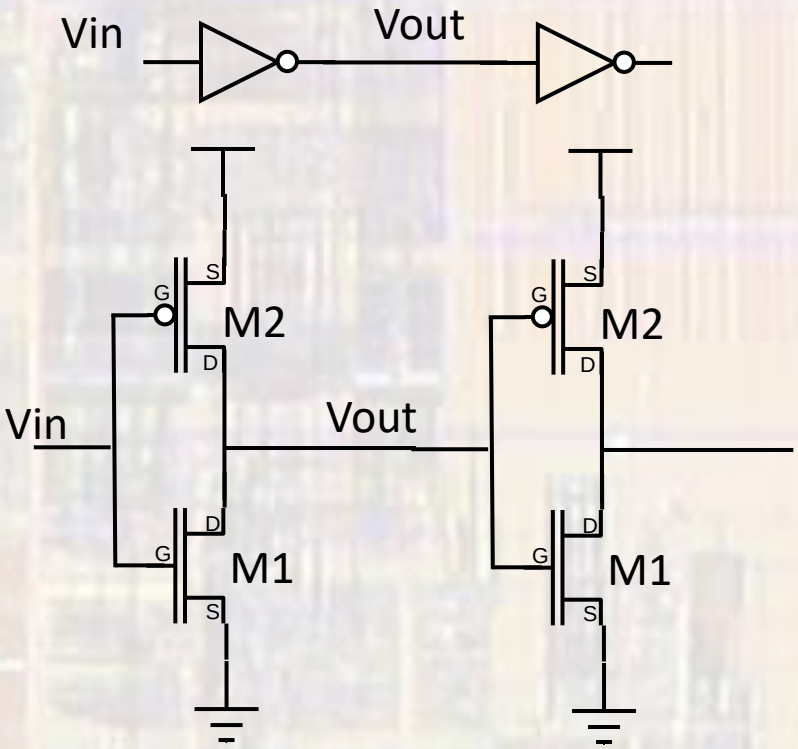
These slides introduce the basics of a CMOS timing

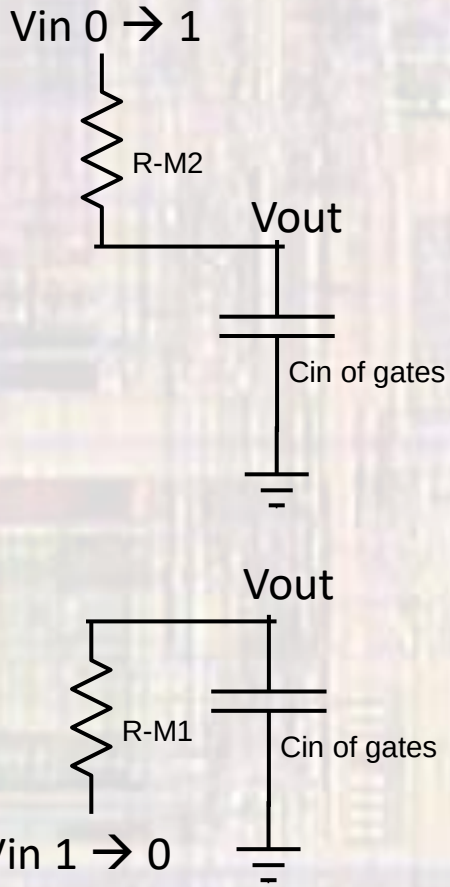
CMOS Timing Characteristics

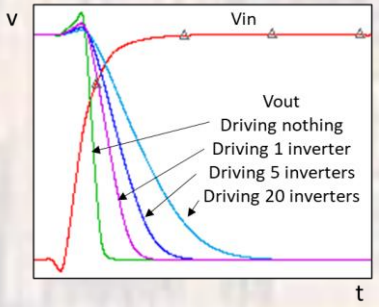
- CMOS Transistor Model
  - Our simplified model of CMOS devices:
    - Transistor D-S path looks like a resistor
      - High valued when off
      - Low valued when on
    - Transistor G looks like a capacitor tied to gnd
  - The D-S resistance can be reduced (increased) by making larger (smaller) devices
  - The G capacitance increases (decreases) for larger(smaller) devices

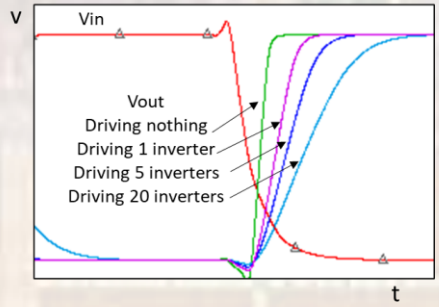
CMOS Timing Characteristics

- CMOS Circuit Model
  - The output of one gate is connected to (drives) one or more gate inputs (Gs)
  - This forms an RC circuit



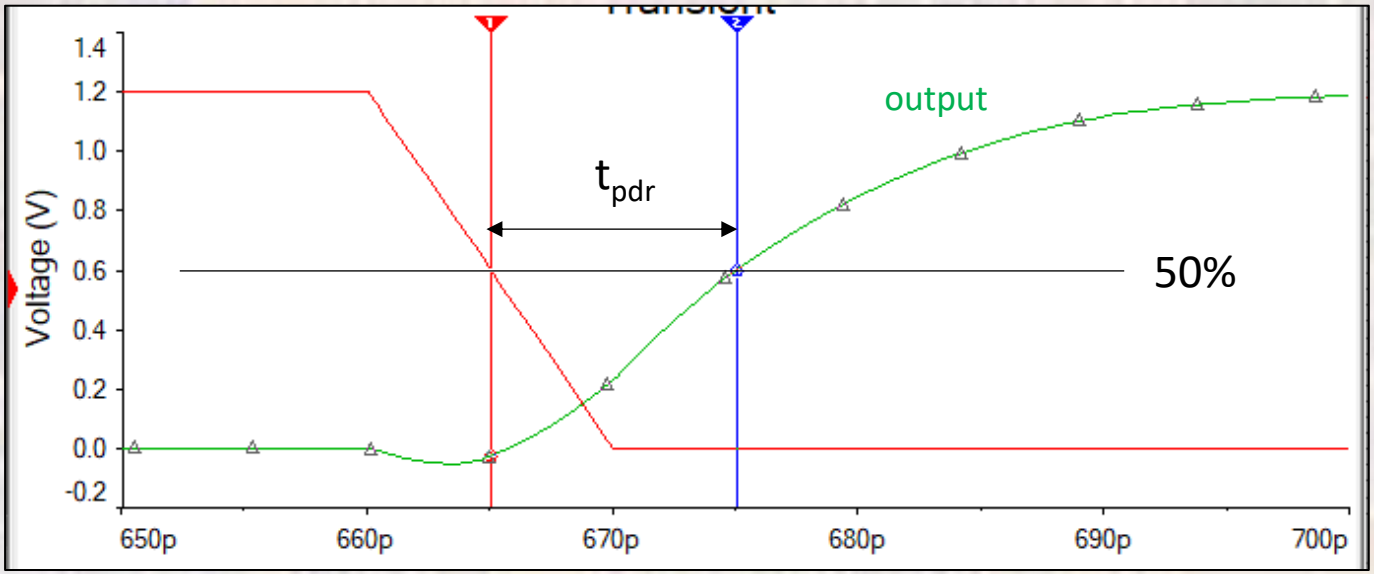






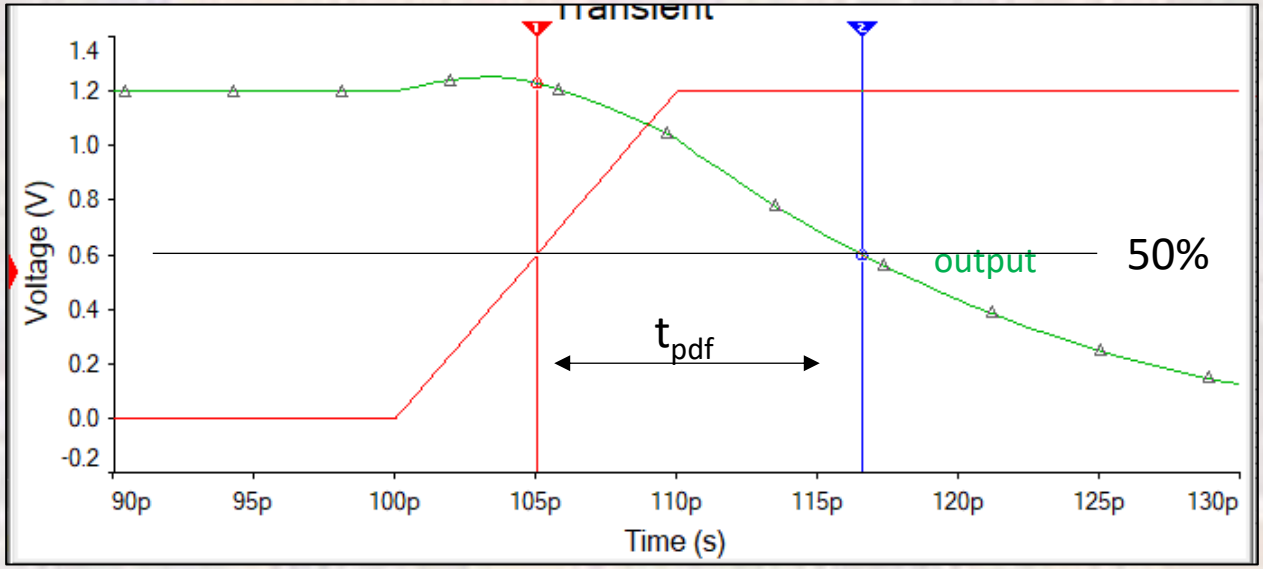
CMOS Timing Characteristics

- Propagation Delay - Rising t_{pdr} t_{pdh}
  - t_{pdr} - Time for Propagation Delay with the output Rising
  - Measured from 50% of input "high" value to 50% of output "high" value on an output rising edge



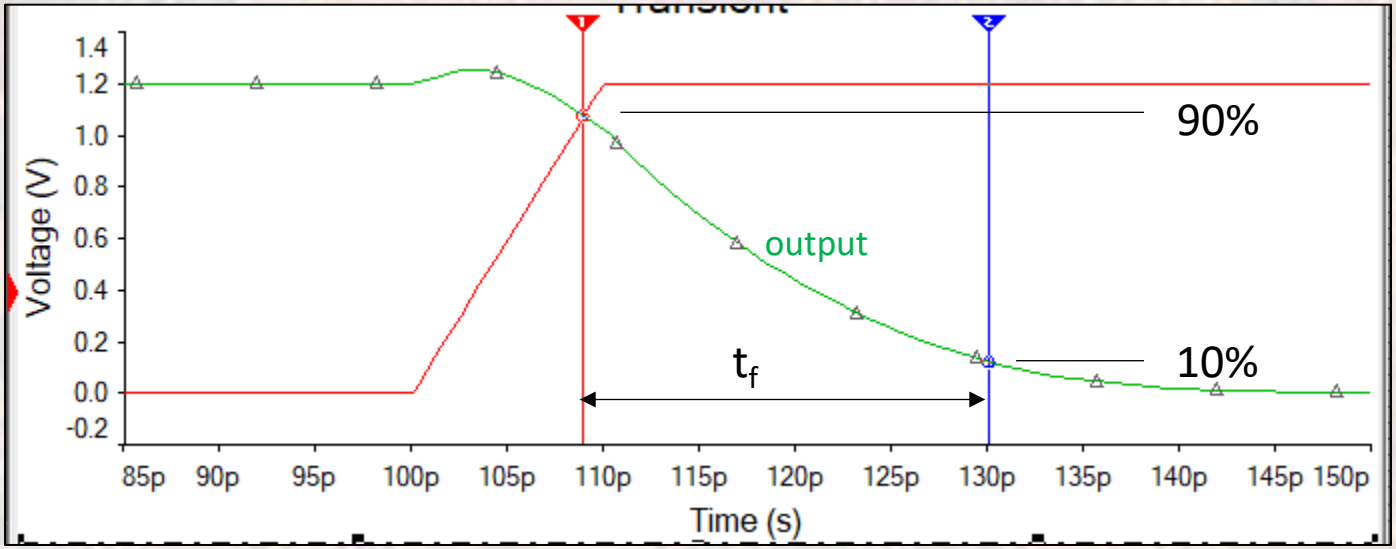
CMOS Timing Characteristics

- Propagation Delay - Falling t_{pdf} t_{pdl}
  - t_{pdf} - Time for Propagation Delay with the output Falling
  - Measured from 50% of input "high" value to 50% of output "high" value on an output falling edge



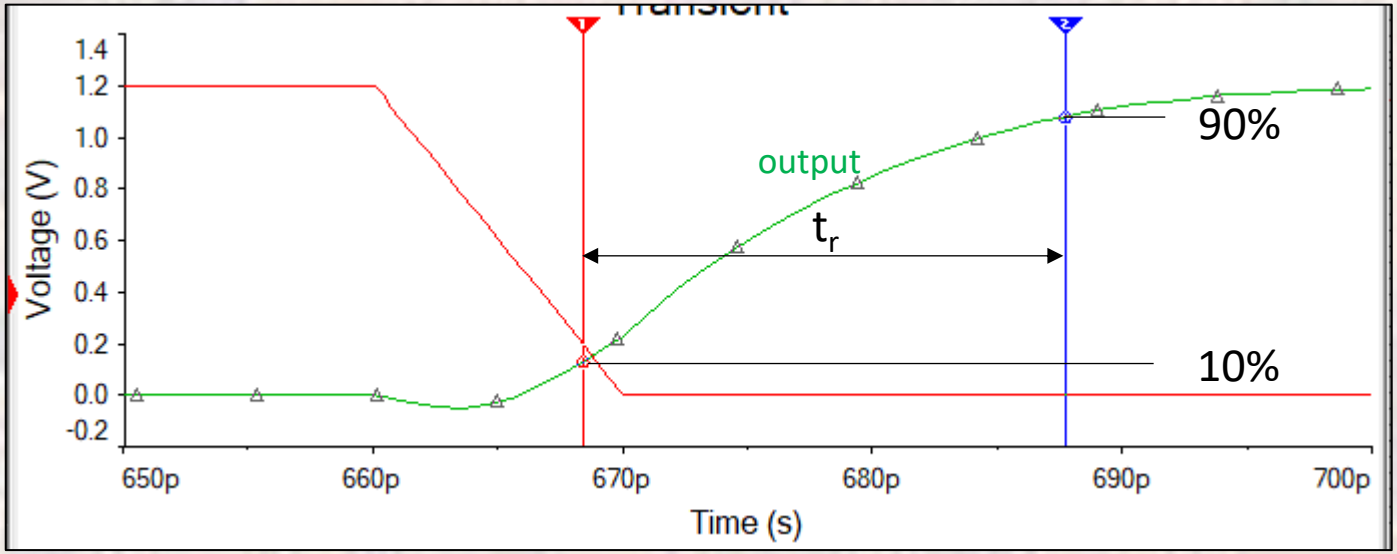
CMOS Timing Characteristics

- Fall Time t_{fall} (t_f)
  - t_f
  - Measured from 90% of "high" value to 10% of "high" value on the output



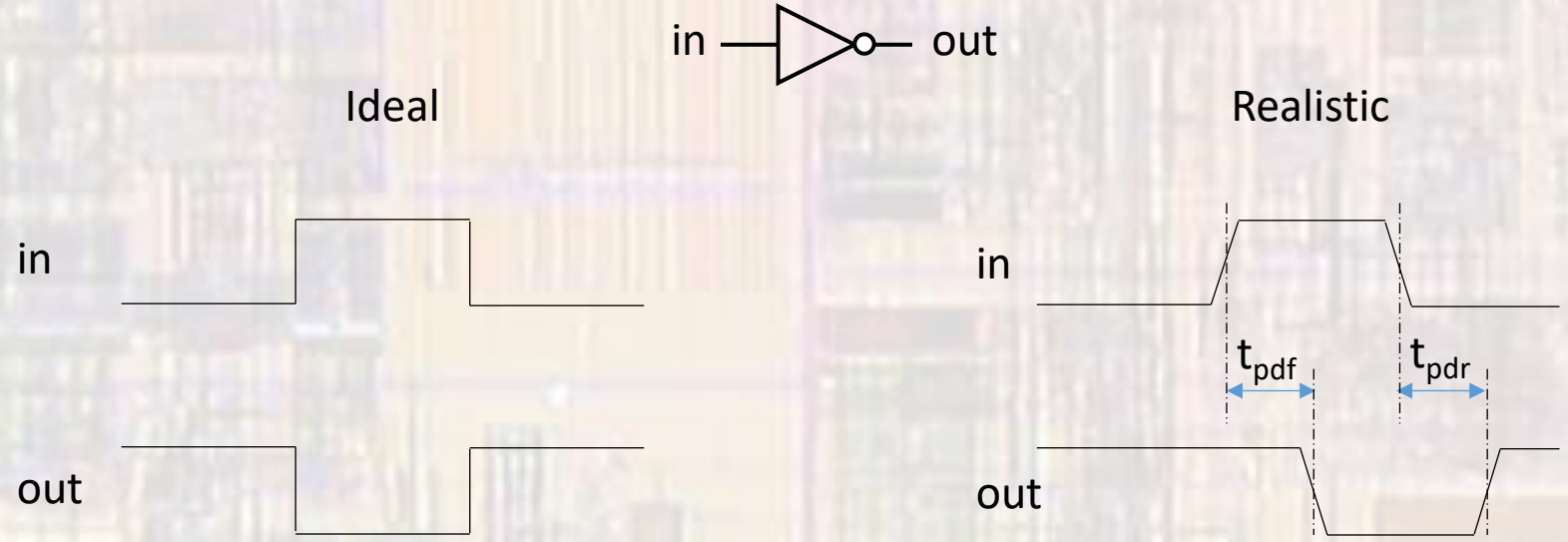
CMOS Timing Characteristics

- Rise Time t_{rise} (t_r)
  - t_r is measured on the output
  - Measured from 10% of "high" value to 90% of "high" value on the output



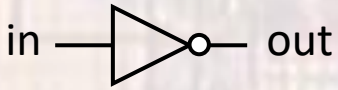
CMOS Timing Characteristics

- Timing Diagrams
  - Propagation Delay
    - Maximum time from when the input changes (50%) to the time when the output reaches its final value (50%)



CMOS Timing Characteristics

- Timing Diagrams



  - Contamination Delay t_{cd}
    - Minimum time from when the input changes (50%) to the time when the output reaches its final value (50%)
    - Delay times change due to:
      - Circuit parameters
      - Temperature
      - Part to part variations