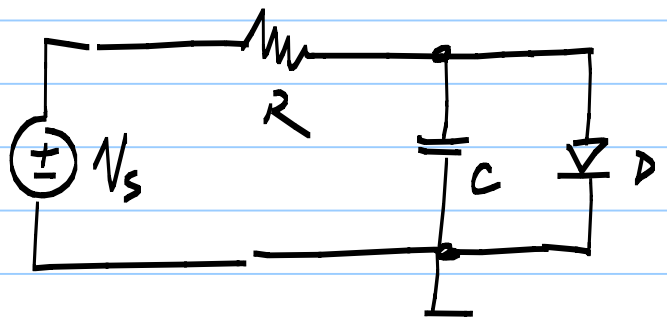
Lecture 44: Circuit simulators



dCop - op. point

ac - small signal incr. analysis

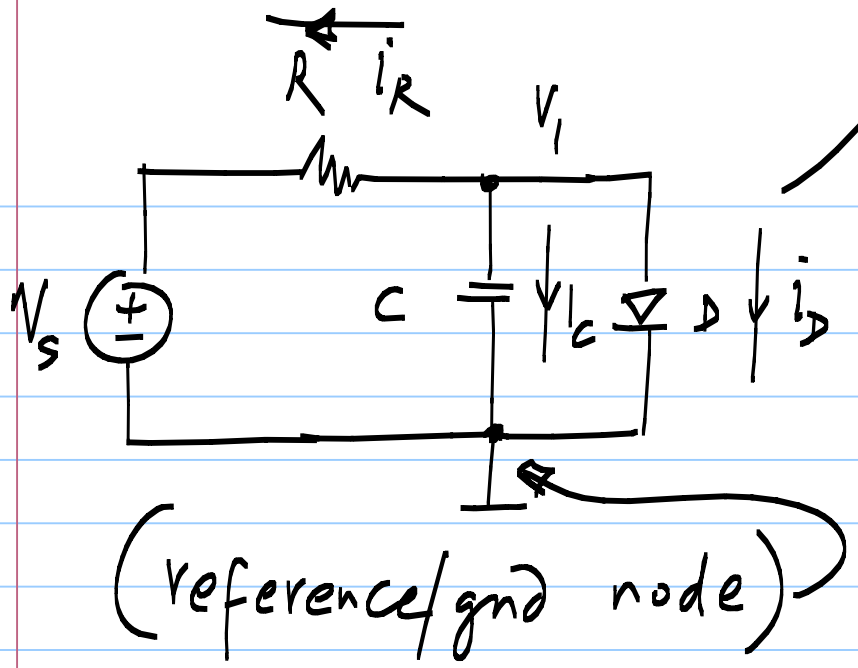
transient - large signal + time-varying signals.

✓ * DC operating point

✓ * Small signal incremental analysis

X * Large signal analysis with time-varying inputs

Need a simulator



Schematic / netlist

Simulator set up

Modified nodal analysis equations (nonlinear) & solve the equations

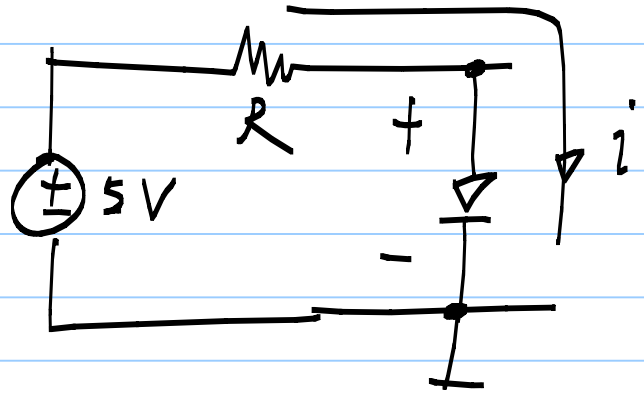
$$C \cdot \frac{dv_1}{dt} + f(v_1) + \frac{v_1}{R} = \frac{v_s}{R}$$

device models

dc operating point:

* open circuit capacitors, short circuit inductors

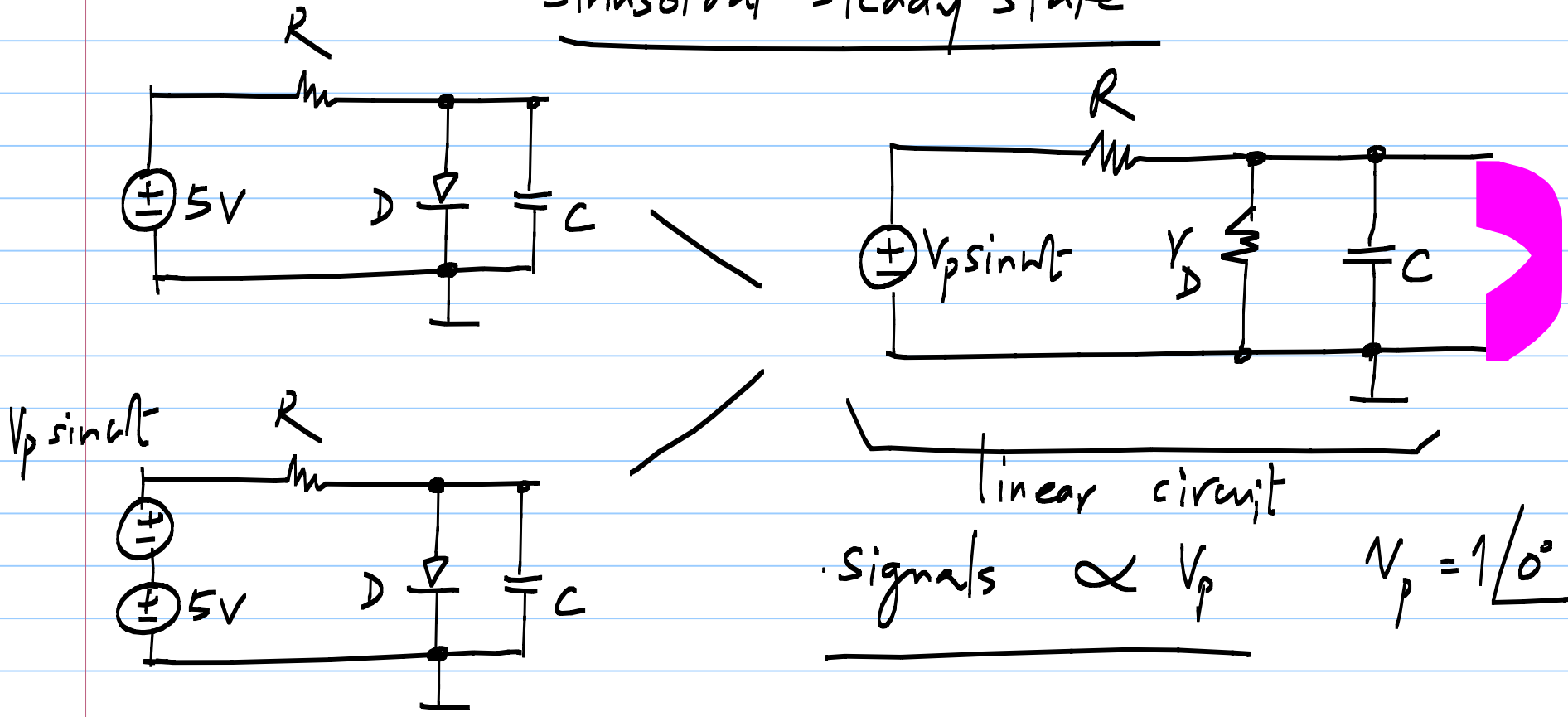
– Nonlinear analysis



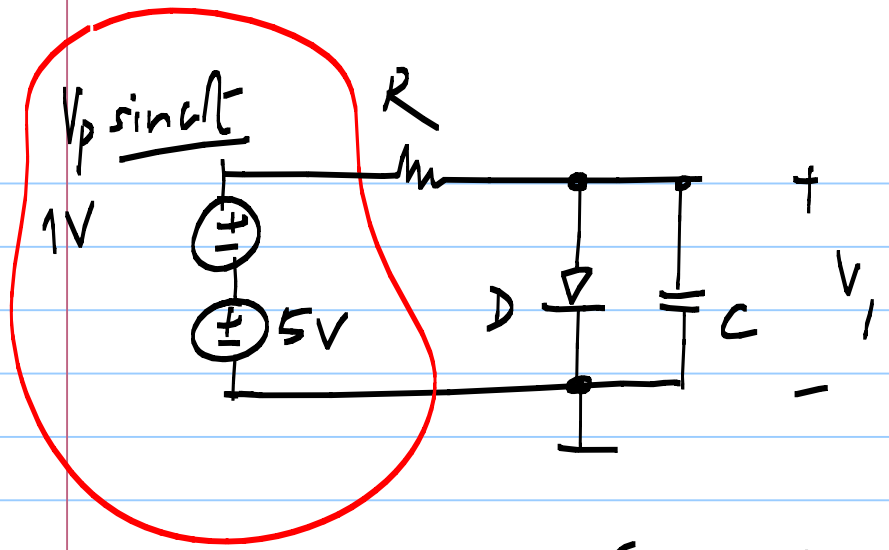
ac analysis – small signal incremental eq. circuit

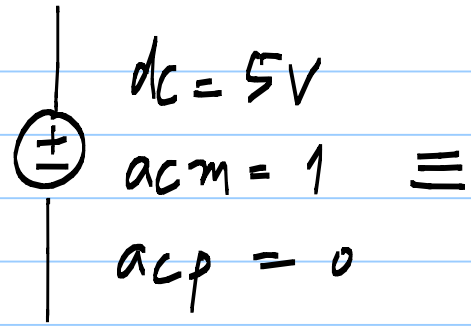
increments: sinusoids at ω

sinusoidal steady state



· signals $\propto V_p$ $\quad V_p = 1\angle 0°$ V





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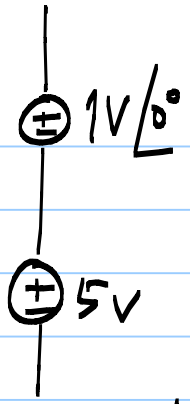
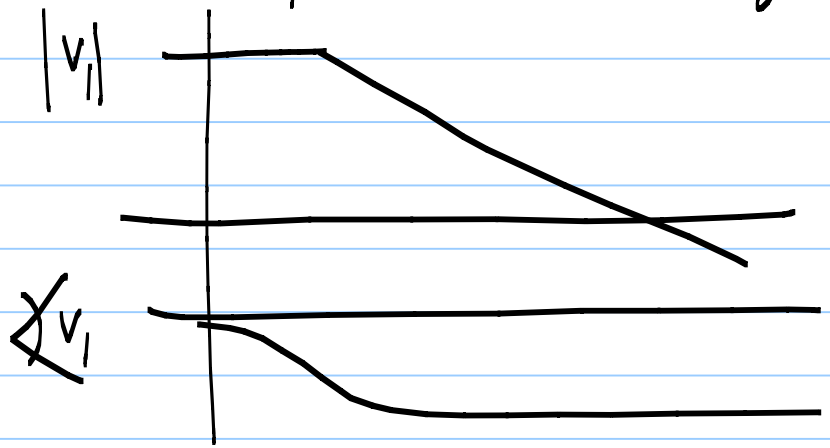
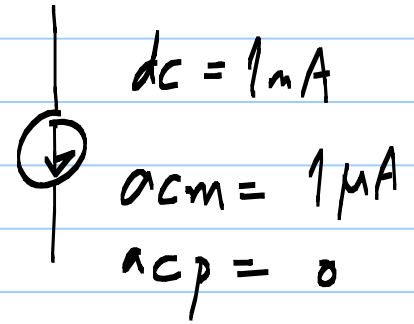


ac: sweep ω (linear / log)





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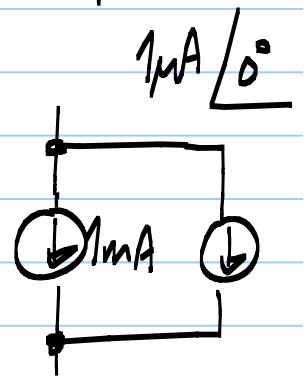
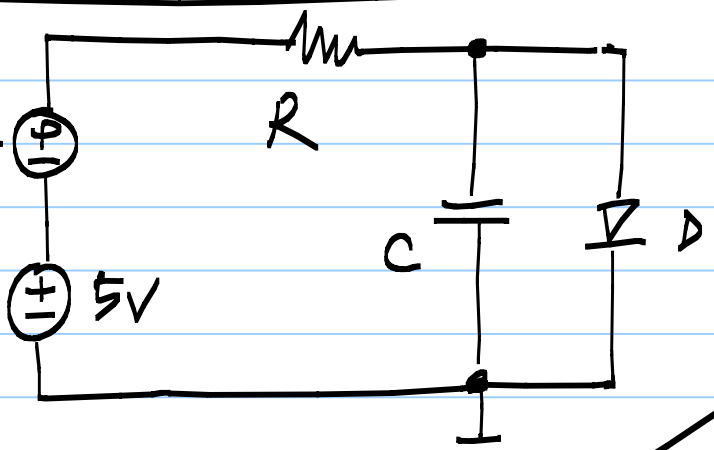


Transient analysis :

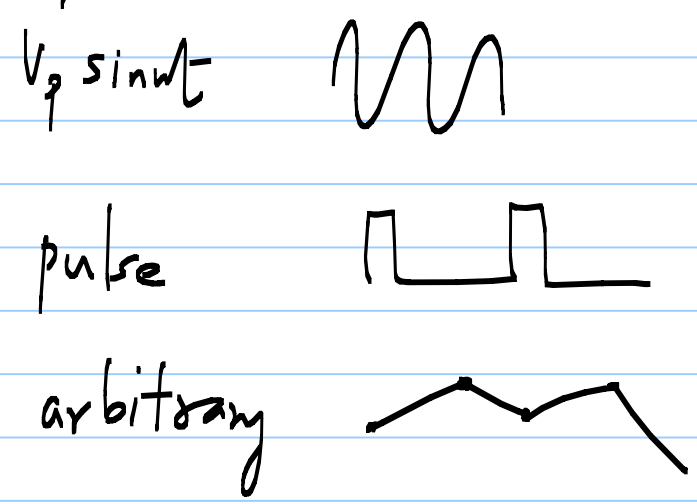


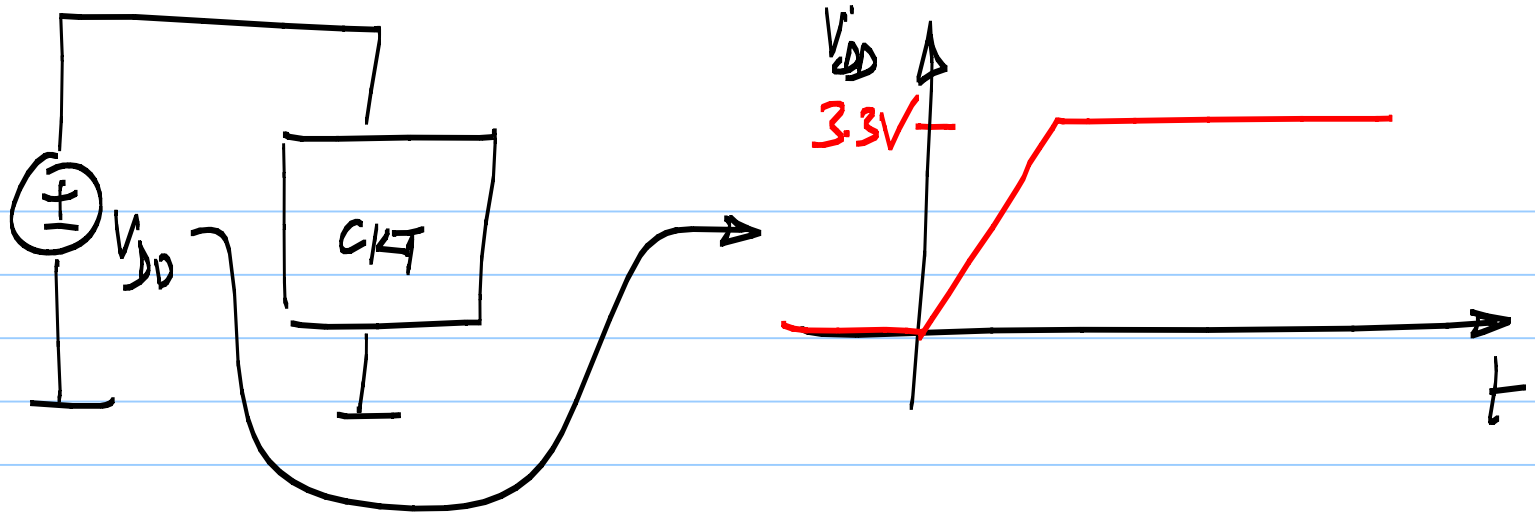
Solve the nonlinear differential equations w/ time varying inputs

V_p will make a difference

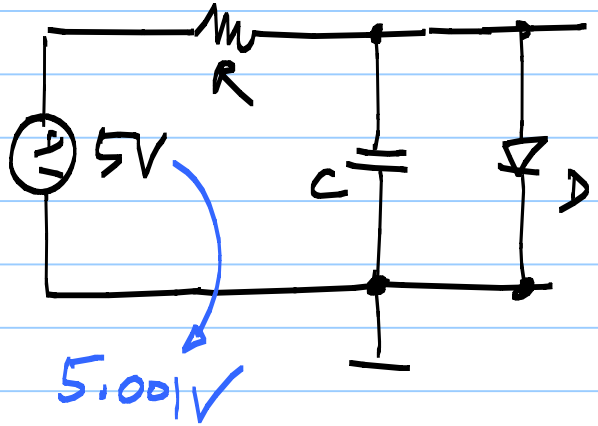
Sinusoidal i/p : Distortion

step response : small/large signal linear/nonlinear ckts

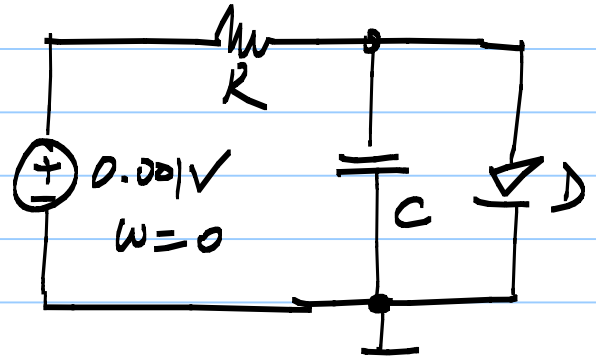


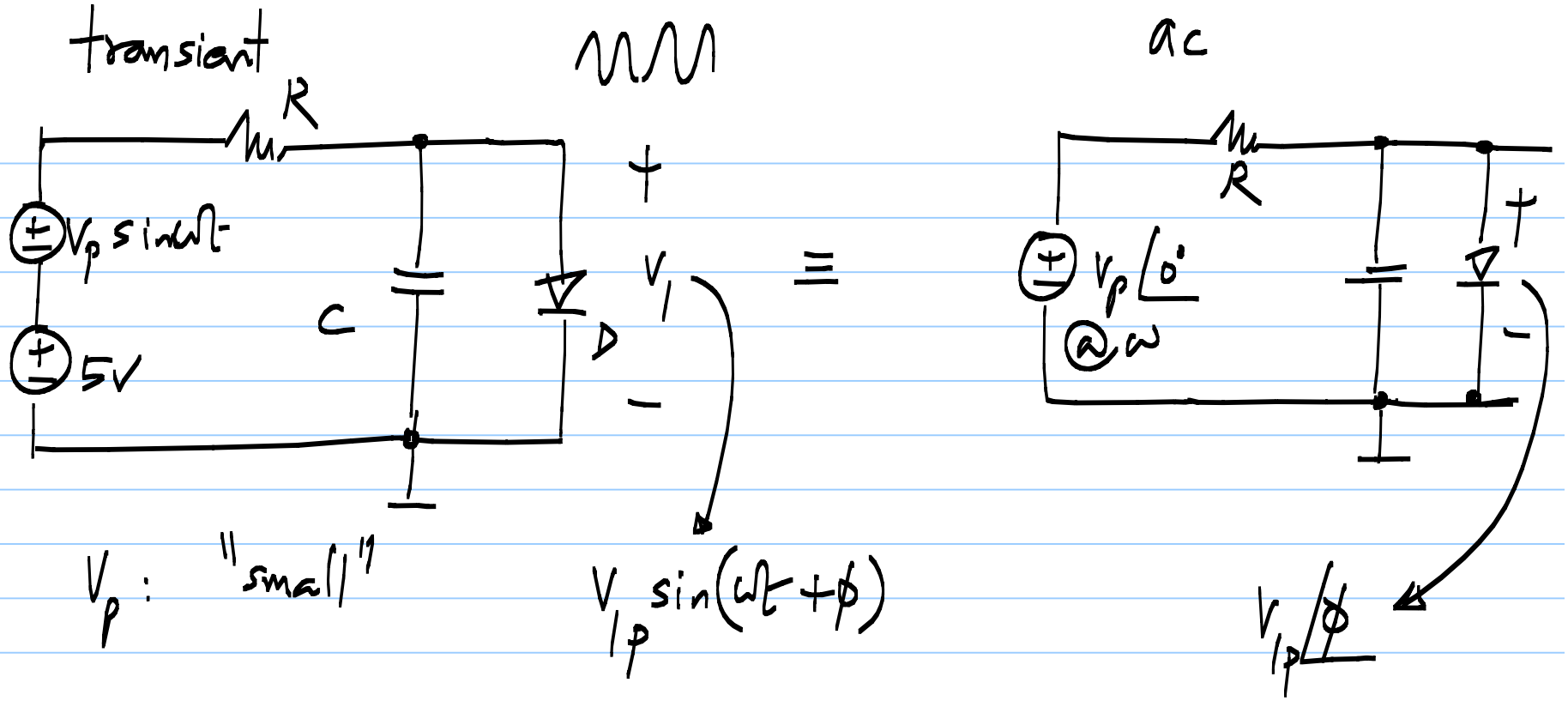


dc op



ac

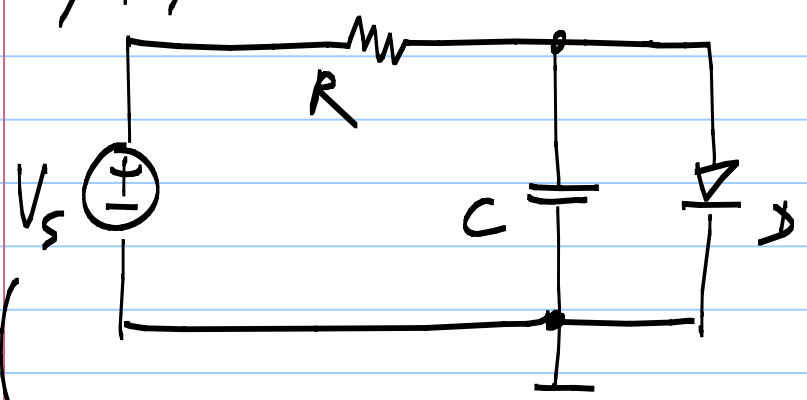



transient
R
$V_p \sin \omega t$
5V
C
D
+
v_1
−
≡
ac
R
$V_p \angle 0°$
@ω
+
−
$V_{1p} \sin(\omega t + \phi)$
$V_{1p} \angle \phi$

V_p : "small"

Sweep
- dc value
- component parameter
- design variables

3V, 4V, 5V



$V_s = \{3V, 4V, 5V\}$

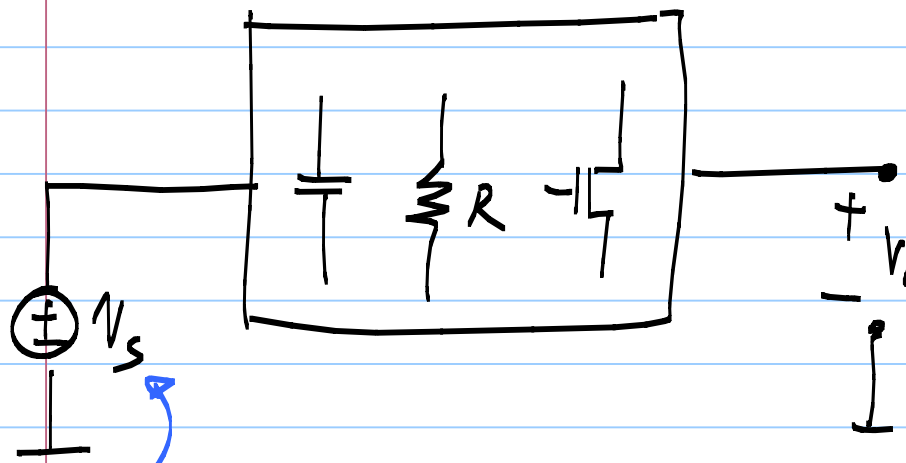
Sophisticated analysis

PSS,

Post-processing:

- DFT
- plot results
- rise/fall times

Noise analysis



Add appropriate noise sources to each component

{ current sources in parallel with R, MOS }

* Output noise (at the specified o/p)

* Input referred noise (to the specified input)