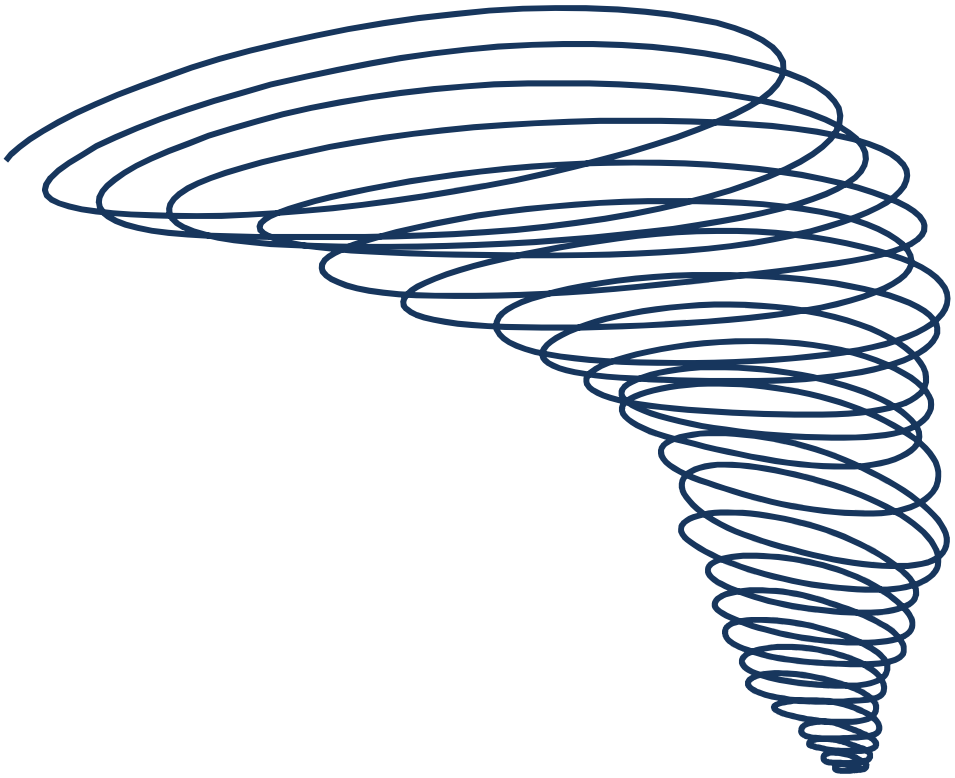
6.002x CIRCUITS AND ELECTRONICS

Op Amps Positive Feedback



6.002x

Nature as observed in experiments

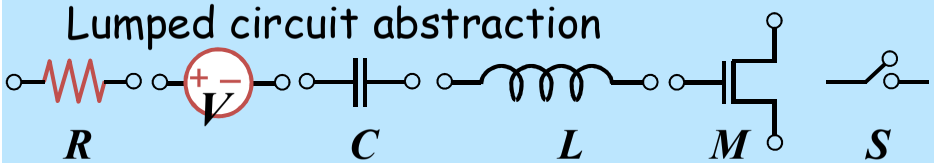
Physics laws or "abstractions"

- Maxwell's
- Ohm's

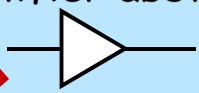
$V = R\,I$

→ abstraction for tables of data

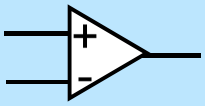
Lumped circuit abstraction



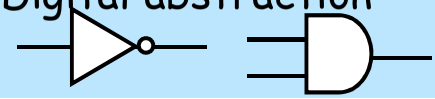
Simple amplifier abstraction



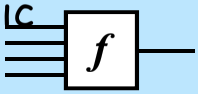
Operational amplifier abstr.



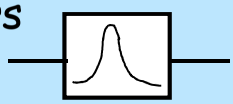
Digital abstraction



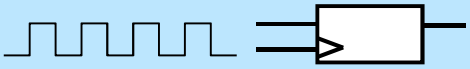
Combinational logic



Filters



Clocked digital abstraction



Instruction set abstraction
Pentium, MIPS 6.004, 6.846

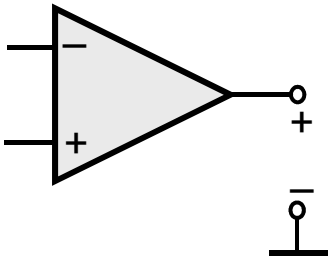
Programming languages
Java, C++, Matlab, Python 6.00

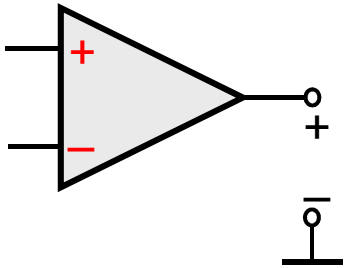
Analog subsystems
Modulators,
oscillators,
RF amps,
power supplies
6.061

Software systems 6.033
Operating systems, Browsers

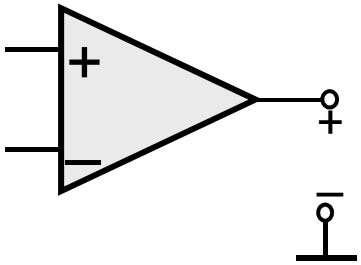
Mice, toasters, sonar, stereos, angry birds,
space shuttle, iPAD 6.455 6.172,6.173

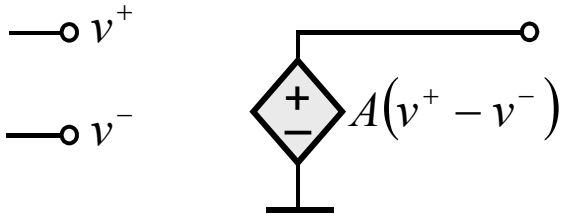
Negative vs Positive Feedback



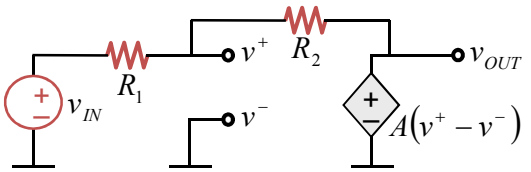


Positive Feedback Ckt



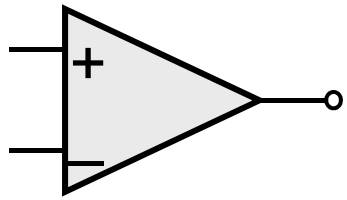


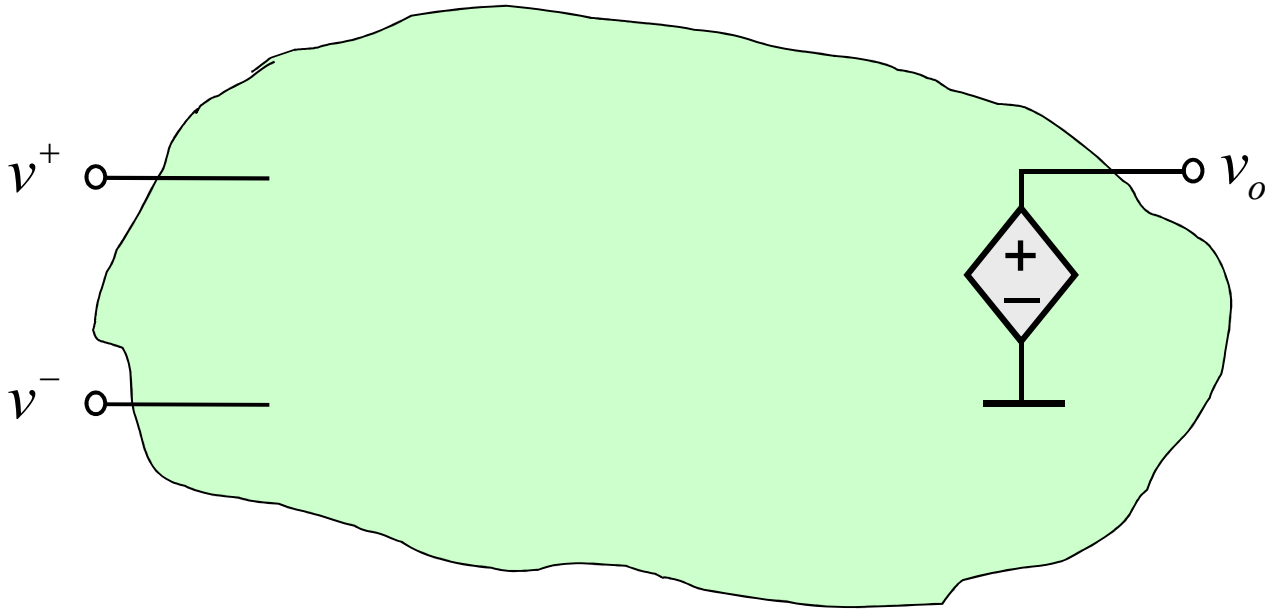
Static Analysis of Positive Feedback Ckt



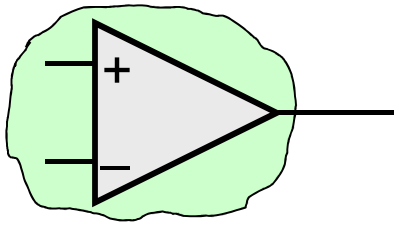
Representing dynamics of op amp

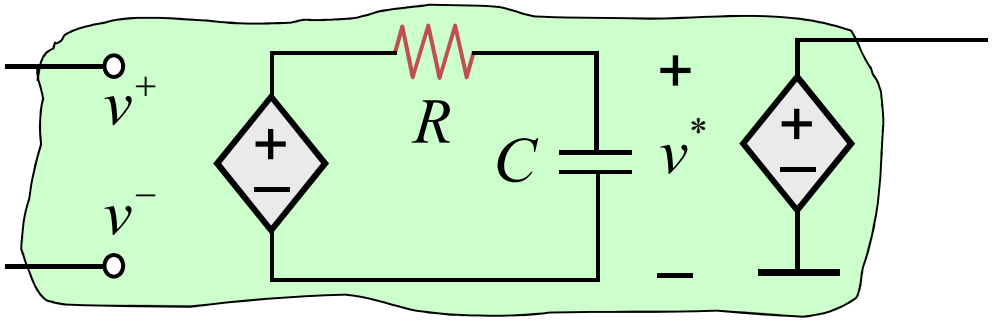
Need a better model to represent temporal behavior of op amp



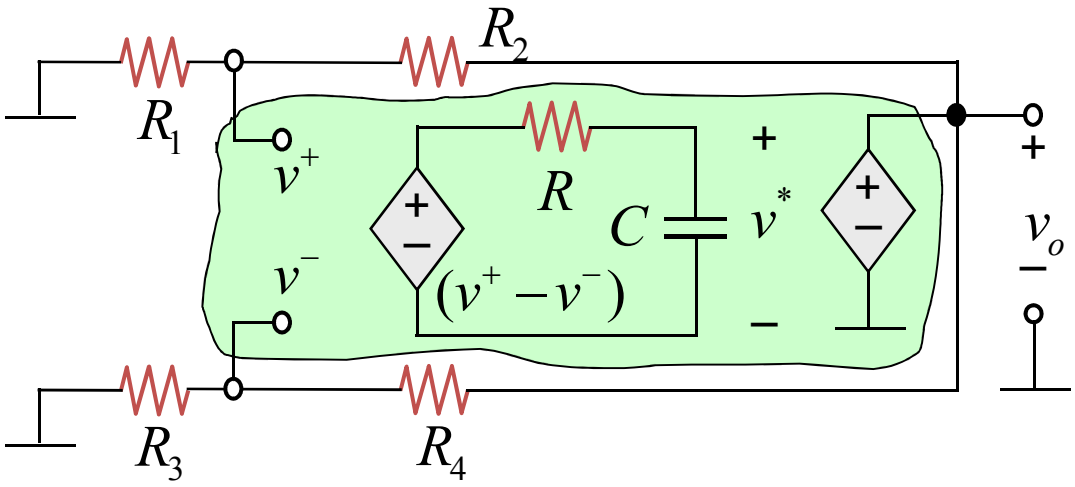


Representing dynamics of op amp…

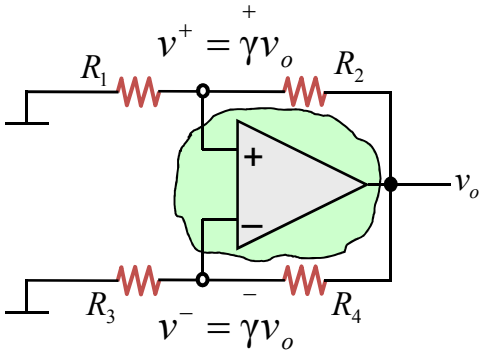




Dynamics of op amp…



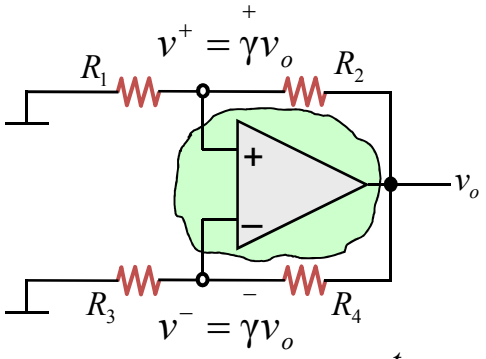
Dynamics of op amp… continued



$$\frac{RC}{A}\frac{dv_o}{dt} + \frac{v_o}{A} = (\gamma^+ - \gamma^-)v_o$$

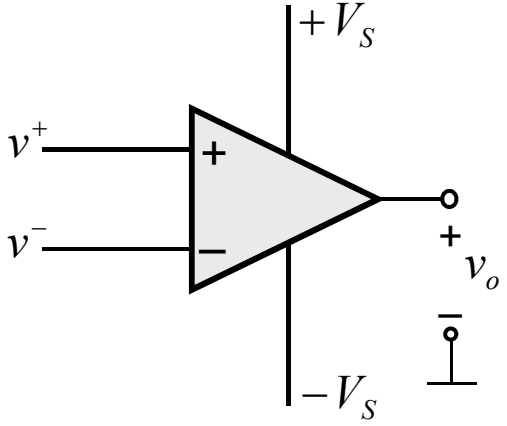
Response to small disturbance of K to v_o (noise)

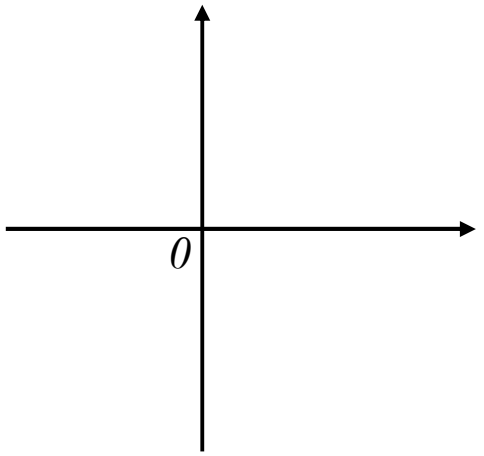


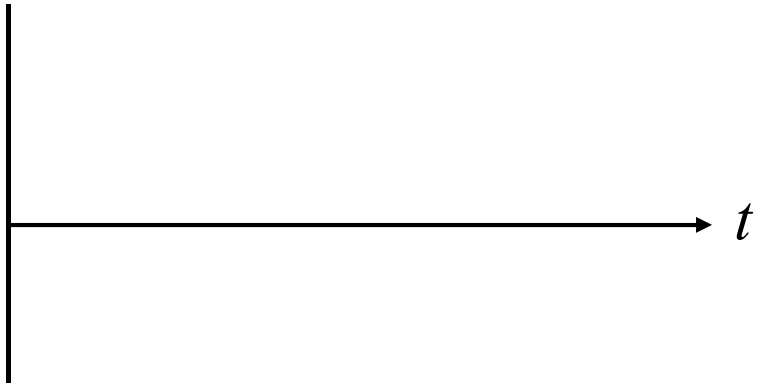


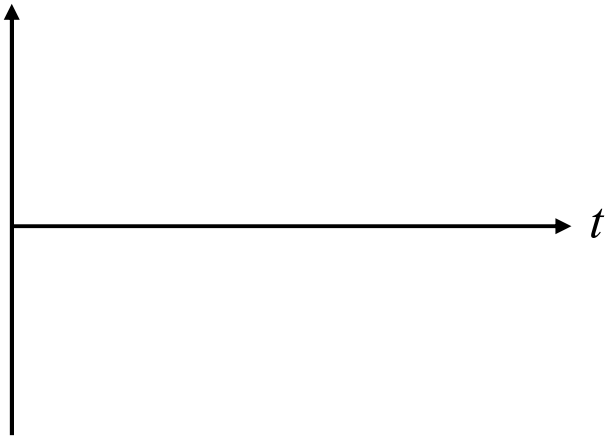
$$v_o = Ke^{-\frac{t}{T}}$$

One use for instability:
Build on the basic op amp as a comparator

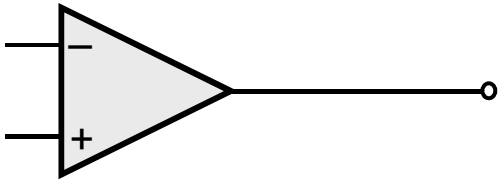




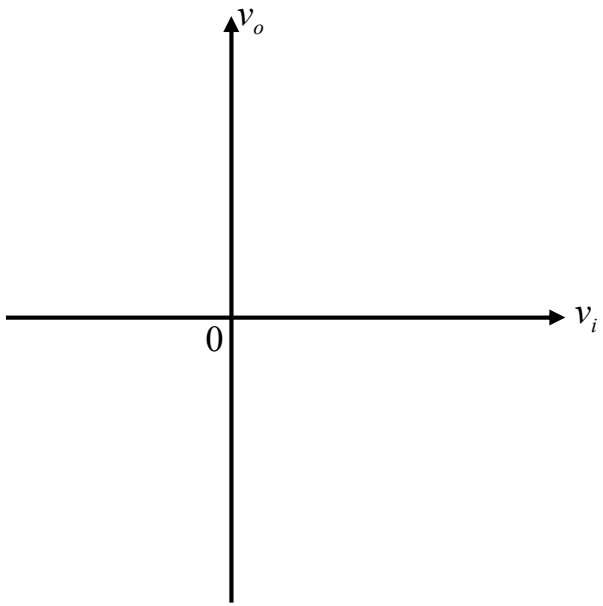


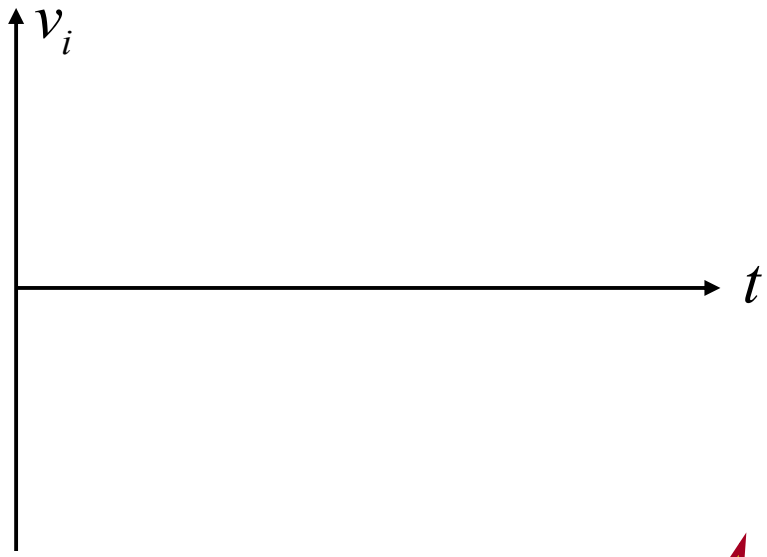


Now, use positive feedback



Hysteresis



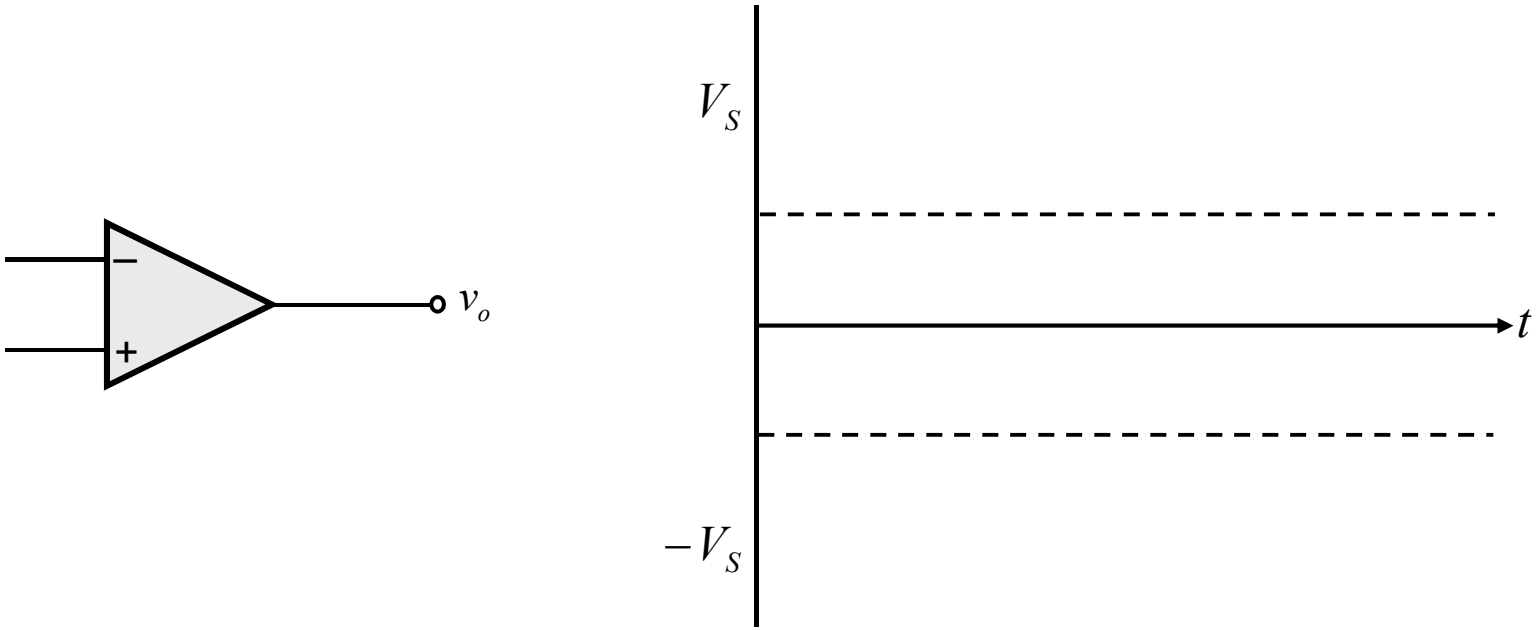


Demo

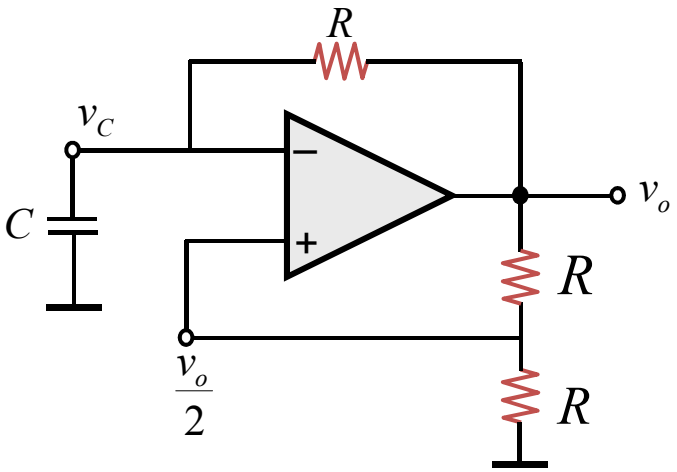
Without hysteresis

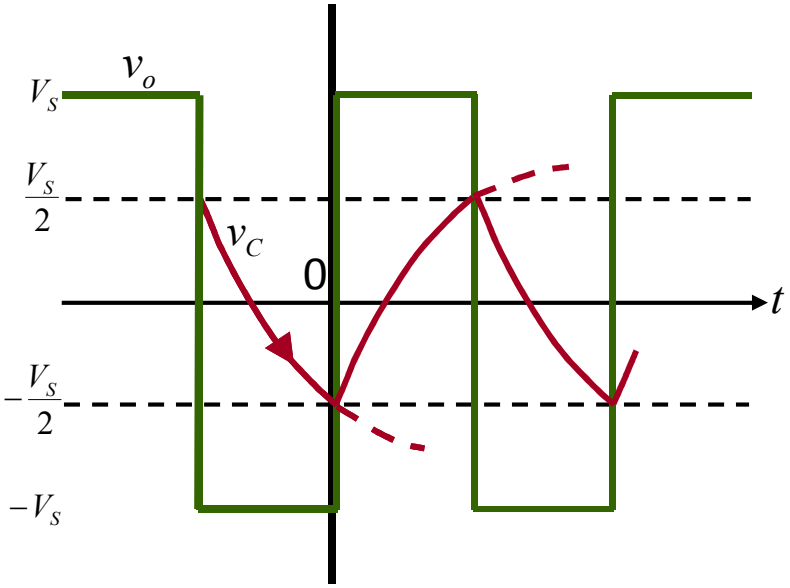


Oscillator — can create a clock

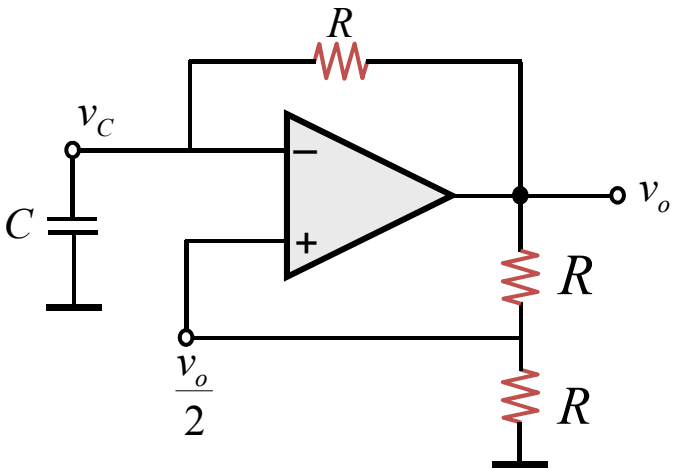


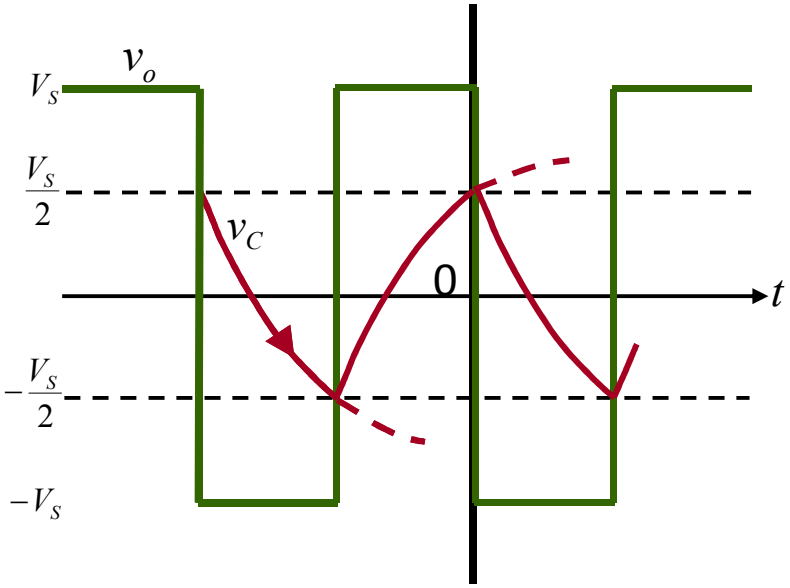
Oscillator — frequency - capacitor voltage rise time



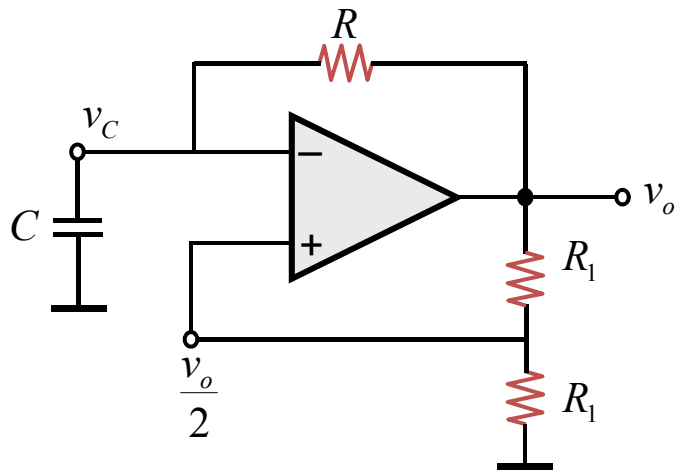


Oscillator — frequency - capacitor voltage fall time

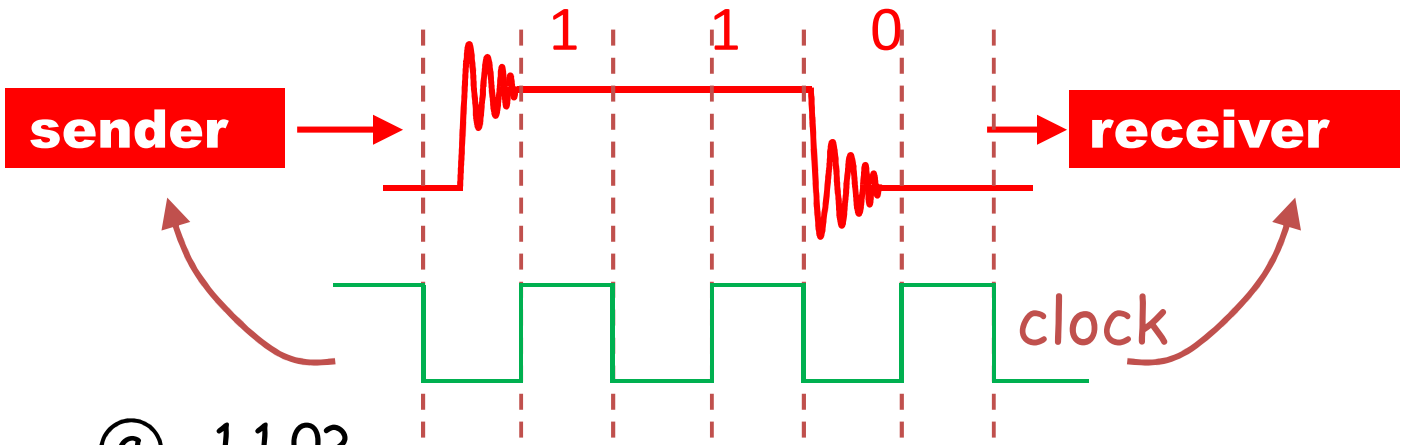




Clocks in Digital Systems



Why Use a Clock in Digital Systems?



ⓐ 1,1,0?

ⓑ When is the signal valid?
common timebase -- when to "look" at a signal
(e.g. whenever the clock is high)

→ Discretization of time – one bit of information associated with an interval of time (cycle)

(See page 555 of A & L)