EECS 16B
Designing Information Devices and Systems II

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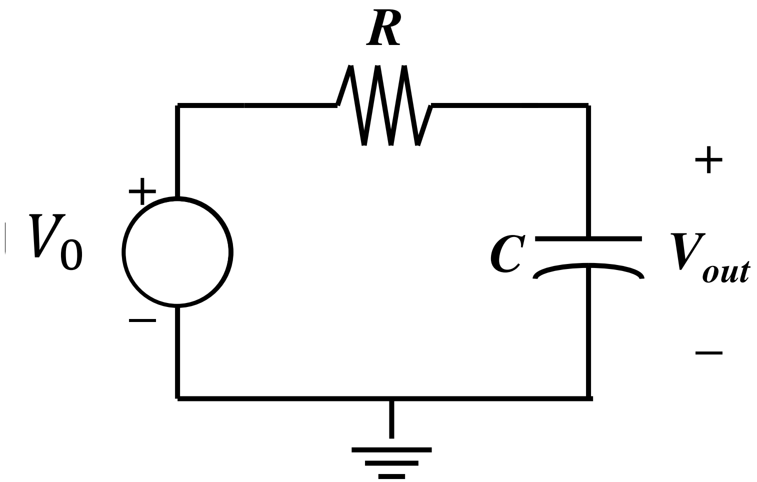
Lecture 2: RC Circuits and First Order Differential Equations

EECS 16B

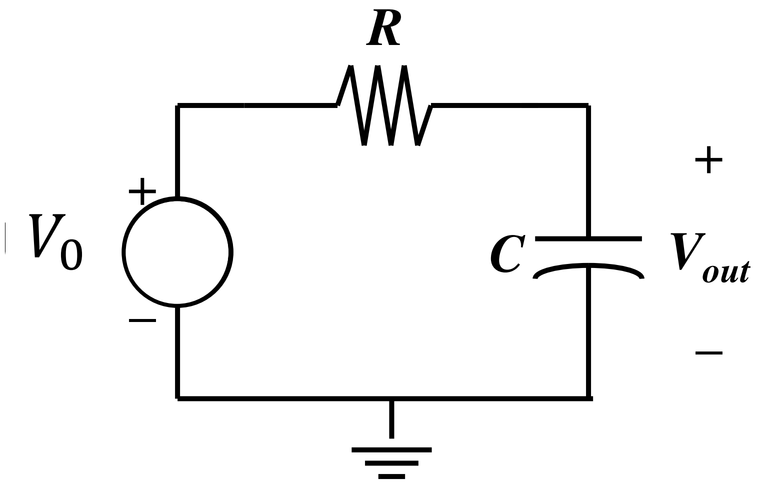
Outline

- Basic RC circuits
- Solving RC circuits with differential equations
  - Steady state
  - Step response
  - Square wave source
  - Sinusoidal source
  - Arbitrary source
- Homogeneous and non-homogeneous equations

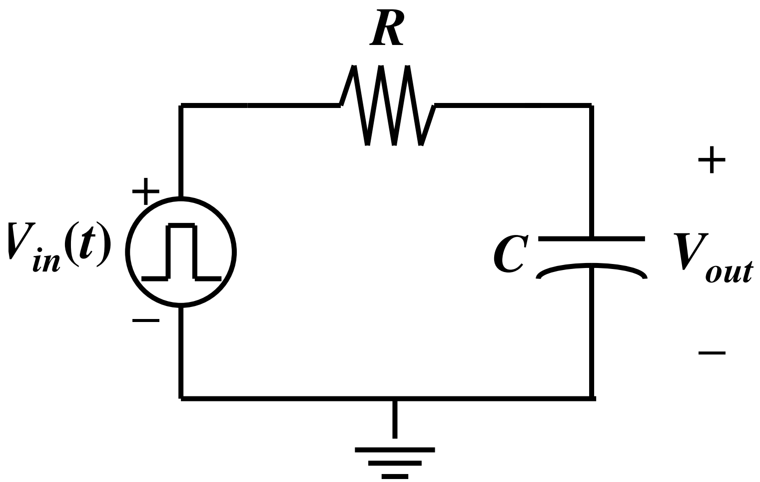
Differential Equation for RC Circuit



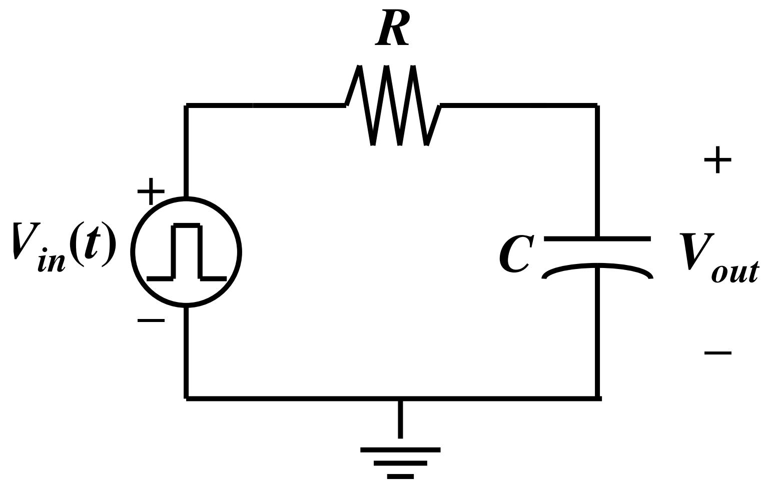
Steady State Solution



Step Response – RC Discharging

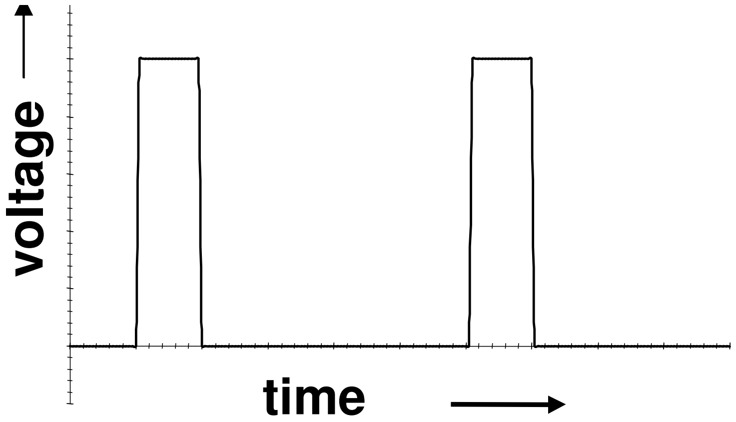


Step Response – RC Charging

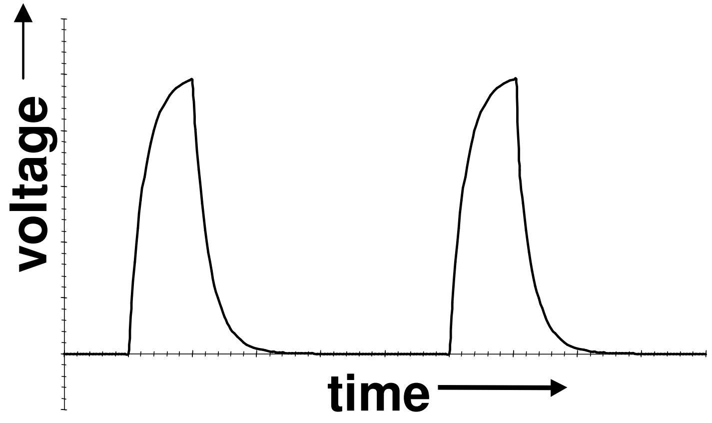


Digital Signals to a RC circuit

- Every node in a real circuit has capacitances

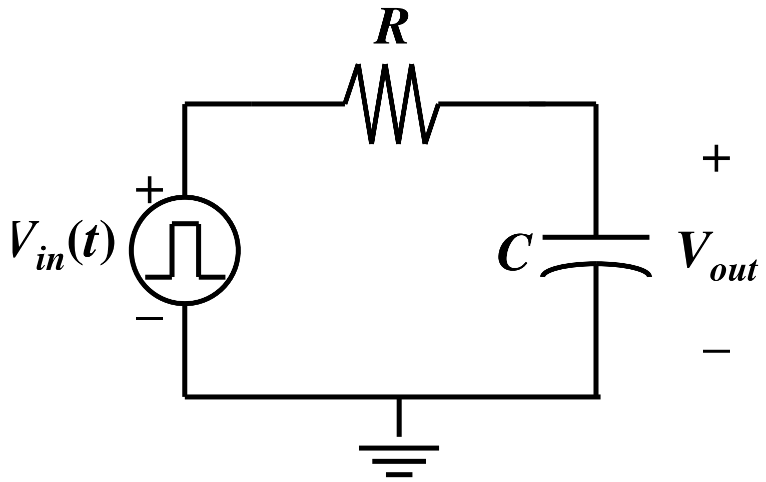


- Even if we send in very 'pure' square looking pulses what we actually get is how it looks in the right due to capacitor charging and discharging unless we go very very slow

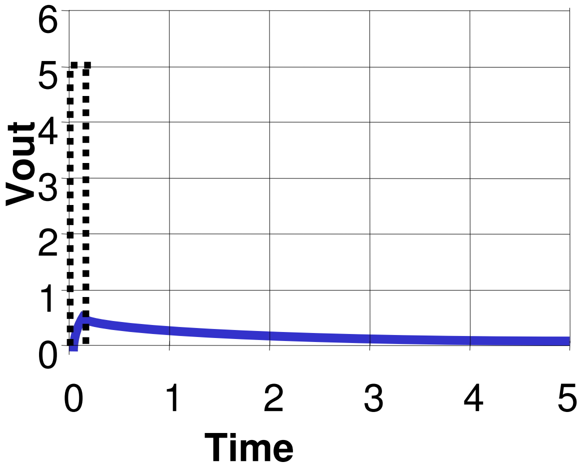


Pulse Distortion

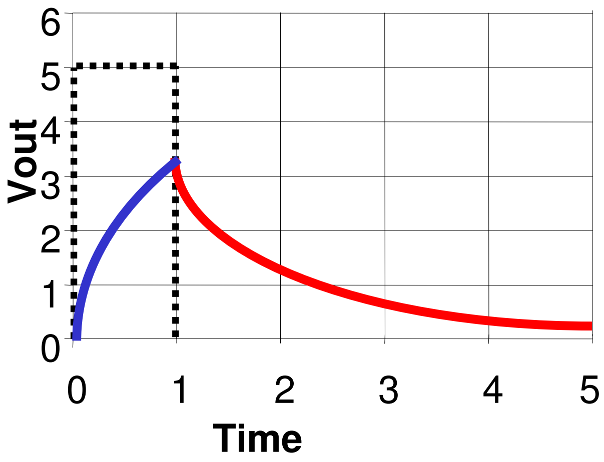
The input voltage pulse width must be large enough; otherwise the pulse is distorted



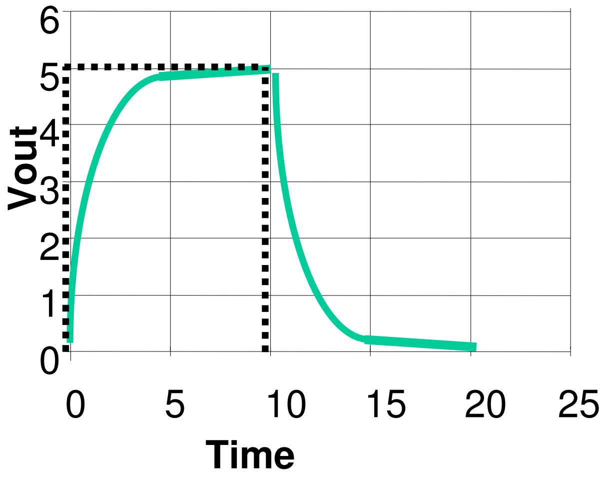
Pulse width = 0.1*RC*



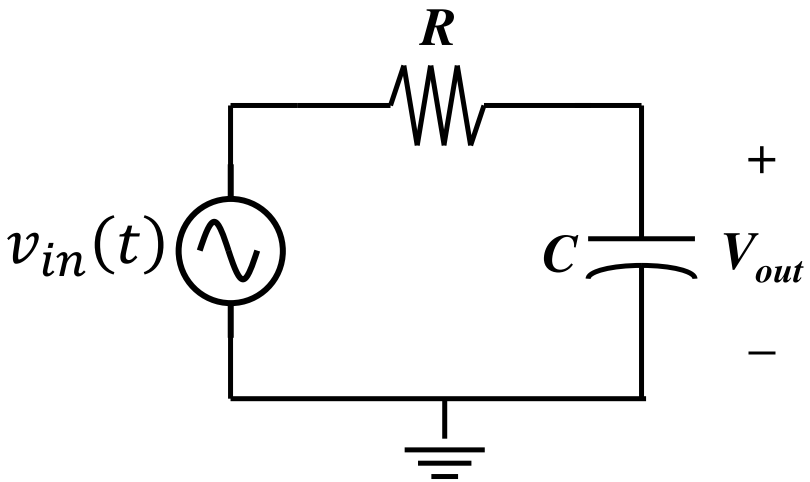
Pulse width = *RC*



Pulse width = 10*RC*



Sinusoidal Input



“Slow Pass” Circuit (Low Pass Filter)

- Suppose a function does not change much on the RC time constant scale

RC Circuit with Arbitrary Inputs

- Now consider an arbitrary source connected to an RC circuit.

“Fast Pass” Circuit (High Pass)

- Now take the output across the resistor. The transfer function can be written as: