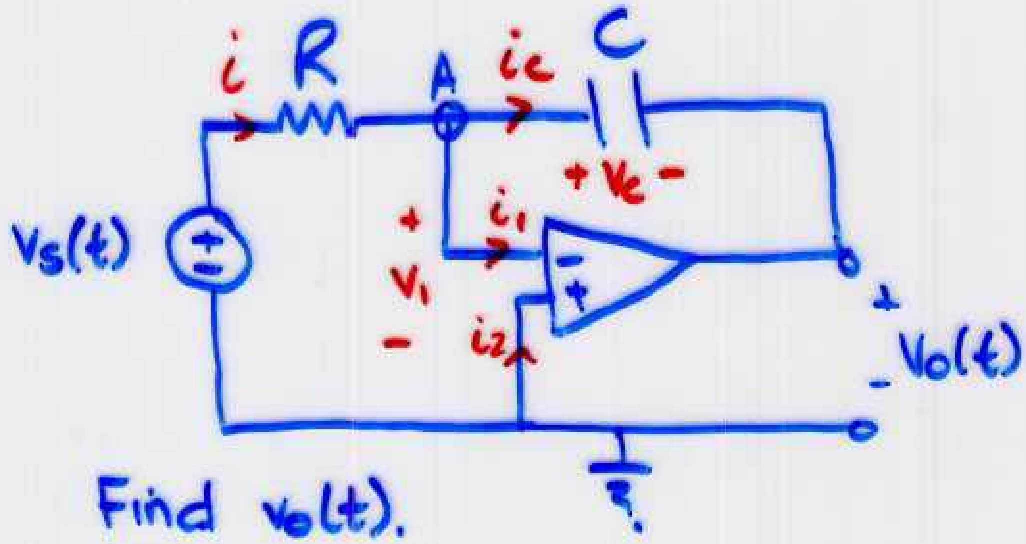
Capacitors + Inductors (Storage or Memory Units)

see Table 7.9-1 in the Text.

	Inductors	Capacitors
		
Voltage	$v = L\, di/dt$	$v = \frac{1}{C}\int_0^t i\, d\tau + v(0)$
Current	$i = \frac{1}{L}\int_0^t v\, d\tau + i(0)$	$i = C\, dv/dt$
Power $= vi$	$p = Li\, di/dt$	$p = Cv\, dv/dt$
Energy	$w = \frac{1}{2} L i^2$	$w = \frac{1}{2} C v^2$
Must be continuous	Current	Voltage.
May be discontinuous	Voltage	Current
	Acts as a short circuit to constant current	Acts as an open circuit to constant voltage
	Acts as an open circuit to rapidly changing ~~current~~ ~~voltage~~ current.	Acts as a ~~closed~~ short circuit to rapidly changing voltage.

OP AMPS + RC CIRCUITS

* KVL, KCL and ideal op-amp assumptions still apply



Find $v_o(t)$.

KVL in source loop

KCL Node A

output loop $\quad v_o(t) =$

$$= V_A(t) - \frac{1}{C}\int_{-\infty}^{t} i_c(\tau)\,d\tau$$

Ideal op amp. $\quad i_1 = i_2 = 0.$

$V_1 = 0 \Rightarrow V_A = 0$

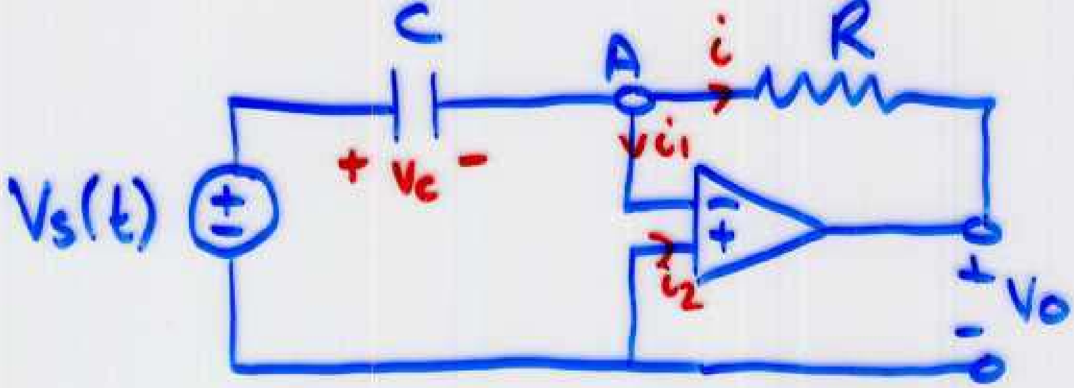
$$\Rightarrow \; i_c(t) = \frac{v_s(t)}{R}$$

$$\Rightarrow \; v_o(t) = -\frac{1}{C}\int_{-\infty}^{t} \frac{v_s(\tau)}{R}\, d\tau$$

$$= -\frac{1}{RC}\left(\int_0^t v_s(\tau)\,d\tau\right) + v_o(0)$$

$\Rightarrow$ Circuit is an integrator

#



From ideal op amp, $V_A(t) = 0$, $i_1 = i_2 = 0$

$V_S(t) = V_c(t) + V_A(t) = V_c(t)$

KCL node A

KVL output loop

Hence

$$v_o(t) = -iR$$

$$= -CR \, dv_s(t)/dt$$

$\Rightarrow$ Circuit is a differentiator.

How will a differentiator perform in the presence of noise?

Ans: generally not very well, because small noisy signals can change rapidly