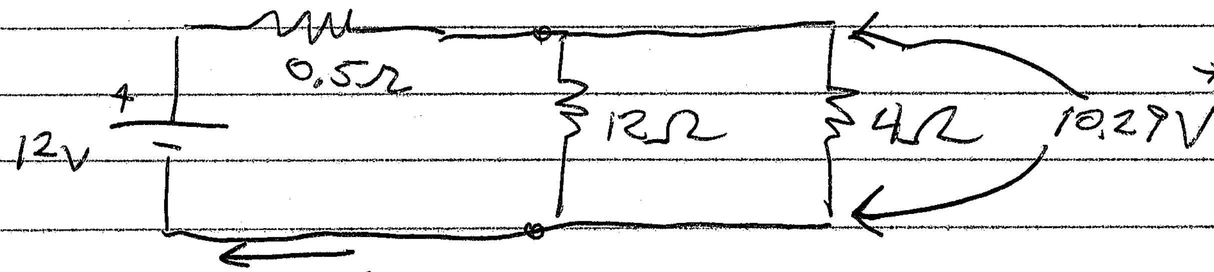
Phys 2426 2015-09-22 Lec 8

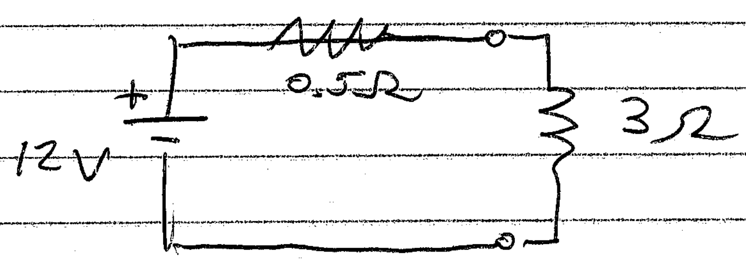
Exam 1 Next tue 9/29

Practice Exam coming soon.



* ~~I = 3.43 A~~

↓ Parallel Equiv.



$$\left(\frac{1}{12}+\frac{1}{4}\right)^{-1}$$

straight Series circuit.

$$R_{Tot} = 3.5\ \Omega$$

$$I = \frac{V}{R} = \frac{12\ V}{3.5\ \Omega} = 3.43\ A$$

$$V_{0.5} = IR = (3.43A)(0.5\Omega) = 1.71\ V$$

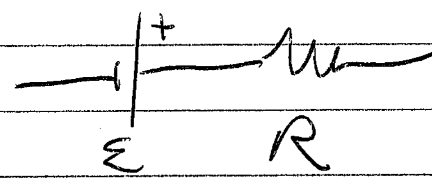
$$V_3 = 12 - 1.71 = 10.29\ V$$

* Transfer Values

Equiv R Method Fails for:
- Multiple Batteries
- Complex meshes of elements (Whetstone Bridge)

Thevenin Equivalent
- Separate part of circuit w/ 2-wire terminal
- Find "open circuit voltage" $= V_o$
- Find "short circuit current" $= I_s$
- Substitute $\mathcal{E} = \cancel{(ocV)}$ V_o

  $R = \cancel{\mathcal{E}/(ssI)}$ $\mathcal{E}/I_s$



Kirchoff's Laws

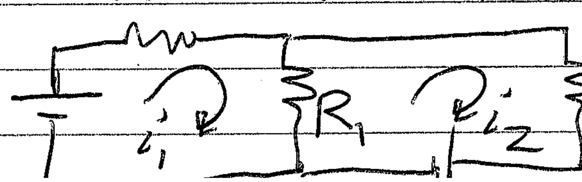
At a junction: $\sum I_{in} = \sum I_{out}$

Around a loop: $\sum V_{rises} = \sum V_{drops}$

Analytical Methods
- Node Voltages - Solve for $V_a, V_b, \ldots$

  $\Delta V = V_b - V_a$, etc.

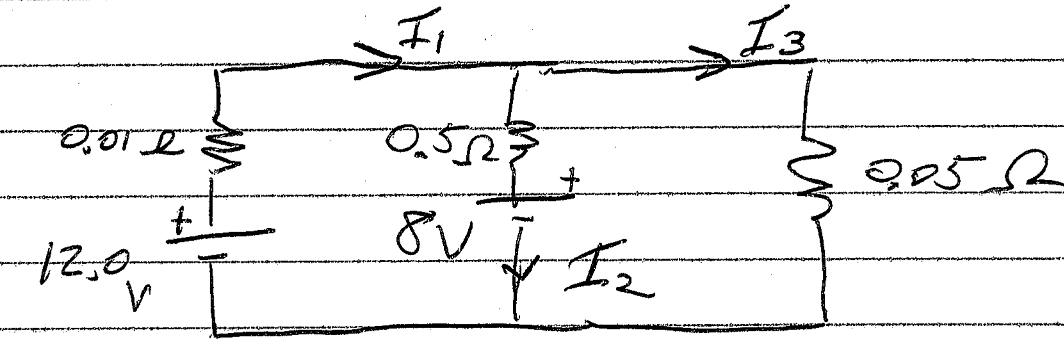
- Mesh Currents - Let i_1, i_2, i_3 be currents in small loops.



$I_1 = i_1 - i_2$

3

- Standard Unknown Current method



Good Batt   Dead Batt   Starter

- Choose measurable currents
- Build Current Eqn.

$$I_1 = I_2 + I_3$$

- Build Loop Eqns. (Hint: follow the currents)

Outer Loop:

12 V	$V_{rise} = 12V$
0.01 Ω	$V_{drop} = 0.01\ I_1$
0.05 Ω	$V_{drop} = 0.05\ I_3$

$$12 = 0.01\ I_1 + 0.05\ I_3$$

Left Loop $(12.0) - (8.0) = 0.01\ I_1 + 0.5\ I_2$

Backward

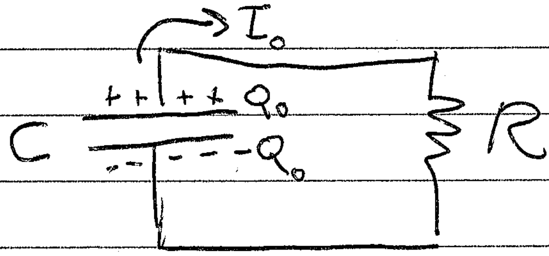
$I_1 = 203$ A

$I_2 = 4$ A

$I_3 = 199$ A

4

Discharging a Capacitor



$$Q = CV_c$$
$$I = V_R / R$$

I is "draining" Q

$$I = \frac{-dQ}{dt}$$

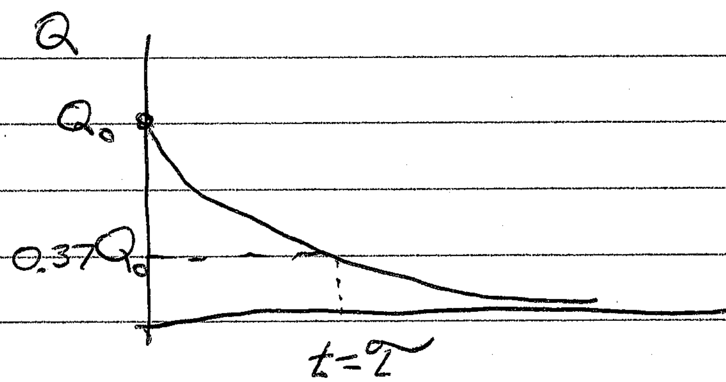
$$\frac{V}{R} = -\frac{dQ}{dt}$$

$$\frac{Q}{RC} = \frac{-dQ}{dt} \qquad \frac{dQ}{dt} = \frac{-1}{RC} Q$$

Solution: $Q = Q_0 e^{-t/\tau}$

$$\frac{dQ}{dt} = Q_0 \left(e^{-t/\tau}\right) \frac{-1}{\tau}$$

Time Constant $\tau = RC$



$e^{-t/\tau}$ is fraction of process to go.

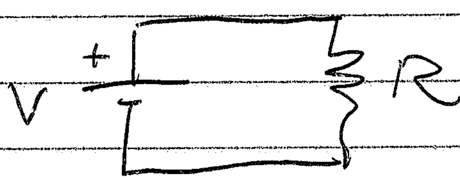
When Discharging all dynamic variables "go as $e^{-t/\tau}$".

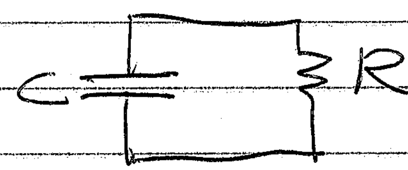
Charge $Q = Q_0 e^{-t/\tau}$

Current $I = I_0 e^{-t/\tau}$

Voltage $V = V_0 e^{-t/\tau}$

Compare Battery to Capacitor





$V =$ const
$I =$ const

V decays
I decays

Battery acts like capacitor that self-charges.

Like a faucet. Like a bucket.

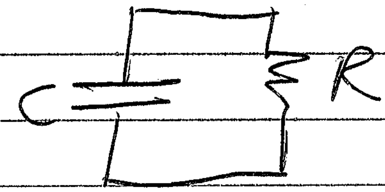
Like an air compressor. Like a portable tank/Balloon.

(6)

Ex: $V = 12.0\ V$

$C = 5.0\ \mu F$

$R = 800\ k\Omega$



Initial Current $\quad I_0 = \frac{V_0}{R} = \frac{12}{8\times10^5} = 15\ \mu A$

Time Constant $\quad \tau = RC = (800\times10^3)(5\times10^{-6})$
$= 4.0\ s$

Time to drain to 6.0 V? (Half-Life)

$$V = V_0 e$$

$$\frac{V}{V_0} = 0.5 = e$$

$$\ln(0.5) = -t/\tau$$
$$-0.693 = -t/\tau$$

$$t = 0.693\ \tau$$

After 0.693 time constants, the capacitor is halfway drained.

$$\lambda = 0.693\tau$$

In this case, $\quad t = (0.693)(4.0\ s)$
$t = 2.77\ s$