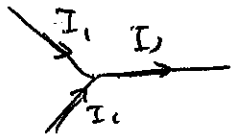
LECTURE 2/25/25

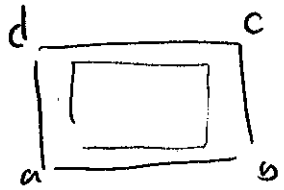
KIRCHOFF'S RULES

KIRCHHOFF'S RULE.

1. CONSERVATION OF CHARGE



2. CONSERVATION OF ENERGY



$$\sum_{\text{CLOSED LOOP}} \Delta V = 0$$

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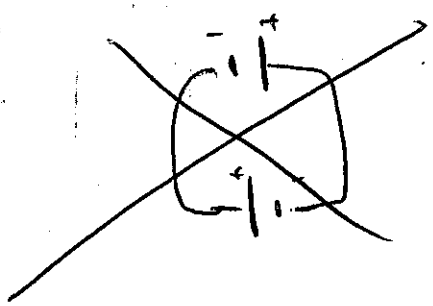
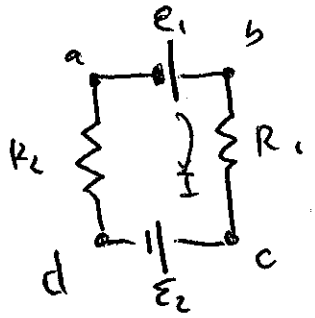
2. EASY EAMPLE





$$\sum \Delta V = 0$$

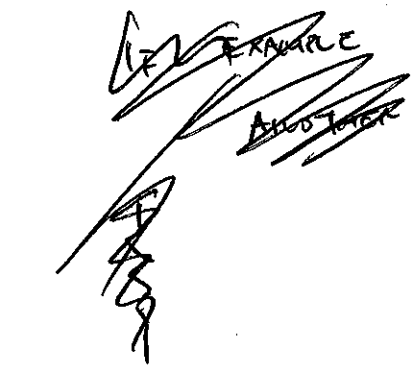
$a \to b \quad +\mathcal{E}_1$

$b \to c \quad -IR_1$

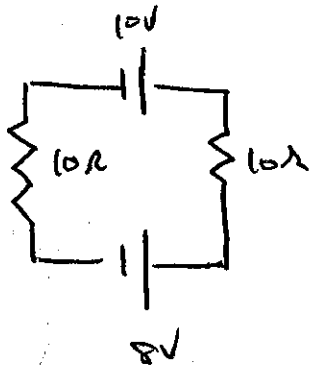
$c \to d \quad -\mathcal{E}_2$

$d \to a \quad -IR_2$

$$\mathcal{E}_1 - IR_1 - \mathcal{E}_2 - IR_2 = 0$$



So IF

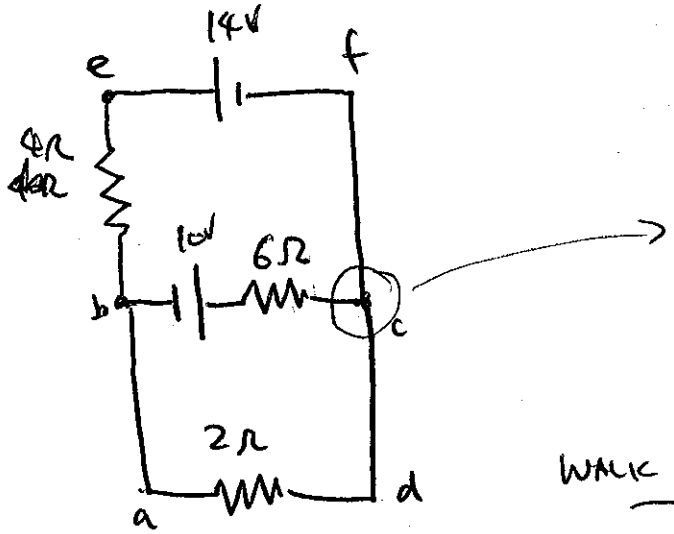


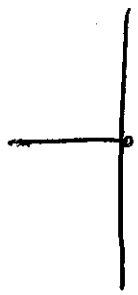
$$10V - I\,10\Omega - 8V - I\,10\Omega = 0$$

$$2V = I\,20\Omega$$

$$\boxed{\frac{1}{10}V = I}$$

EXAMPLE 2

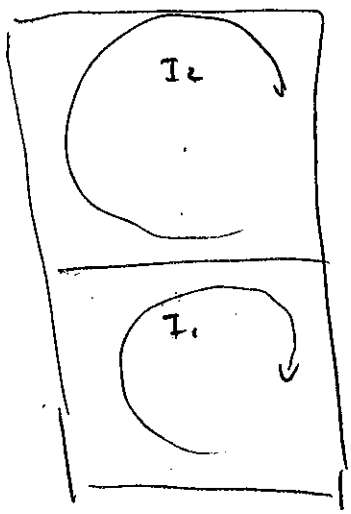




FIND CURRENTS

WALK THROUGH THIS ONE SLOWLY

CLOSED LOOPS



abcda: ΔV

$a \to b$ 0

$b \to c$ $-6\Omega(I_1 - I_2)$

$c \to d$ $-10V$

$d \to a$ $-I_1 2\Omega$

befc: $b \to e$ $-6\Omega I_2$

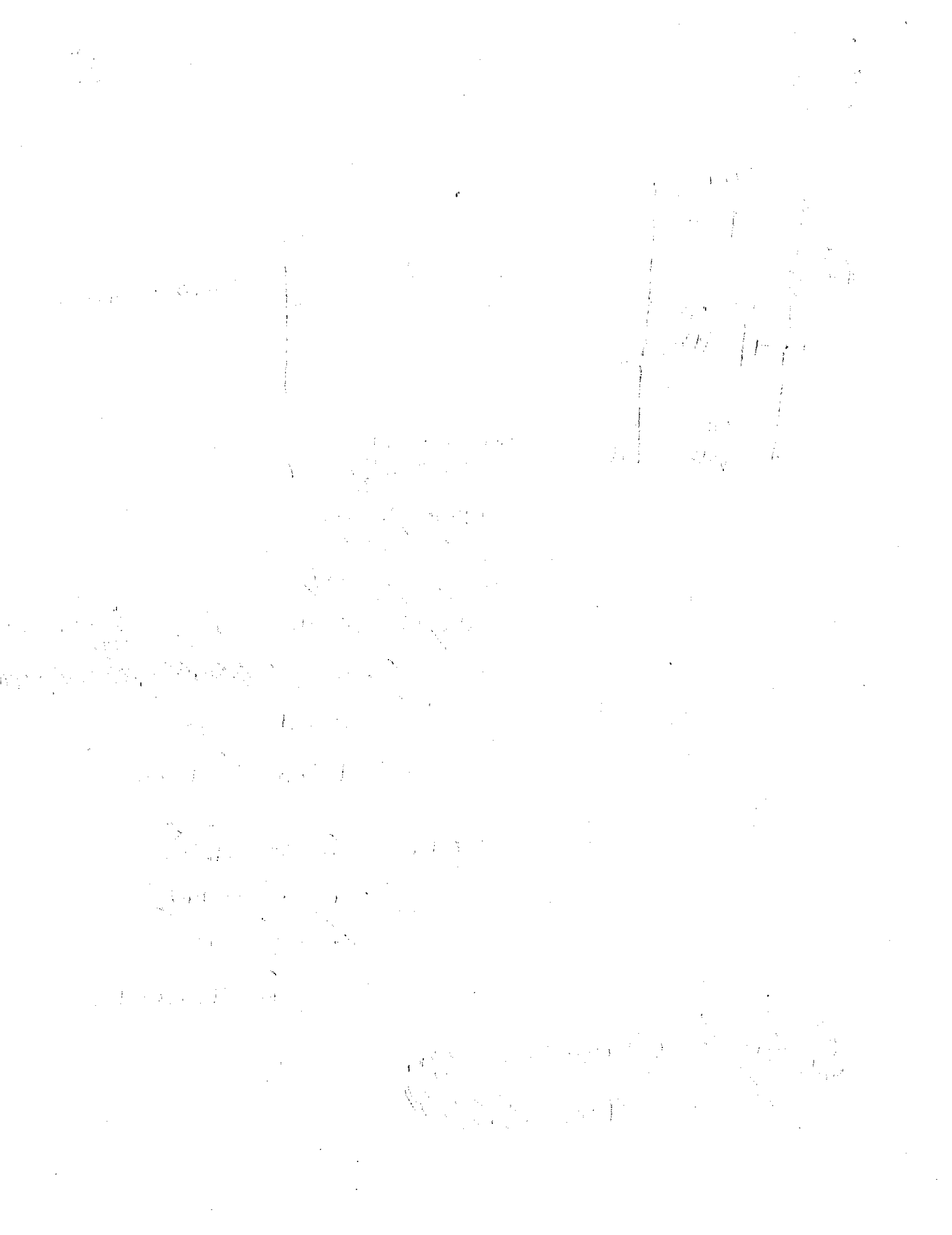
$e \to f$ $-14V$

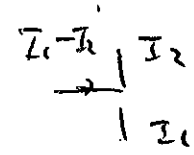
$f \to c$ 0

$c \to b$ $-I_2 6\Omega - 10V$

$\sum_{\text{loop}} \Delta V = 0 = 0 + 10V - 6I_1 - 2I_1$

$10V - 8I_1 = 0$





1st $-10V - 6(I_1 - I_2) - 2I_1 = 0$

$10V - 6I_1 + 6I_2 - 2I_1 = 0$

$8I_1 - 6I_2 = 10V$

2nd loop $-4I_2 - 14 - 6(I_2 - I_1) - 10V = 0$

$-10I_2 + 6I_1 = 24$

$8I_1 - 6I_2 = 10V$

$-10I_2 + 6I_1 = 24 \times \frac{4}{3}$

$8I_1 - 6I_2 = 10V$

$-\frac{40}{3}I_2 + 8I_1 = 32$

$(-6 + \frac{40}{3})I_2 = -22V$

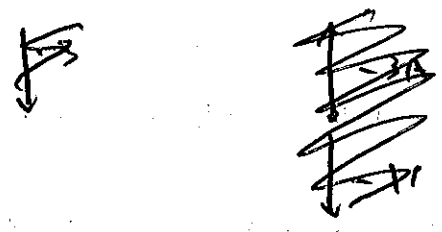
$\frac{22}{3} I_2 = -22V$

$I_2 = -3A$

POT INTO 2)

$$+30\,V + 6I_1 = 24$$

$$I_1 = -1A$$



$-3A$

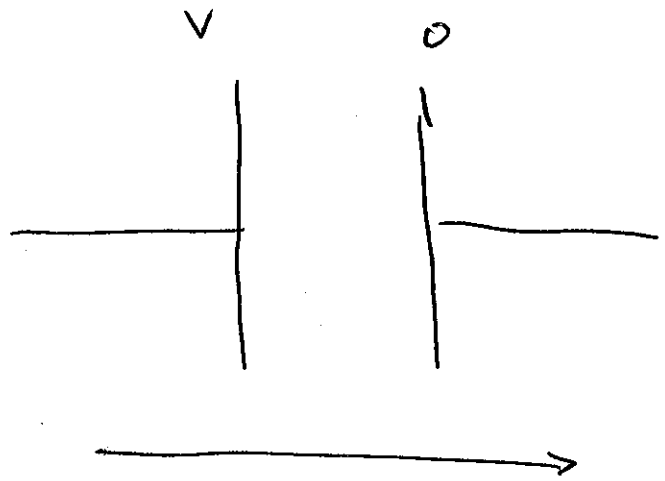
$-1A$

$$I_2 + I_3 = I_1$$

$$-3A + I_3 = -1A$$

$$I_3 = 2A$$

CAPACITORS How??

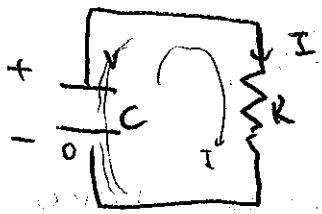


$$\Delta V = \frac{Q}{C}$$

$$\Delta V = -\frac{Q}{C}$$

RC CIRCUITS

CAPACITOR



$V(t)$ $\quad Q(t)$

$$\frac{dQ}{dt} = I(t)$$

$$I = \frac{V(t)}{R}$$

$$Q = CV$$

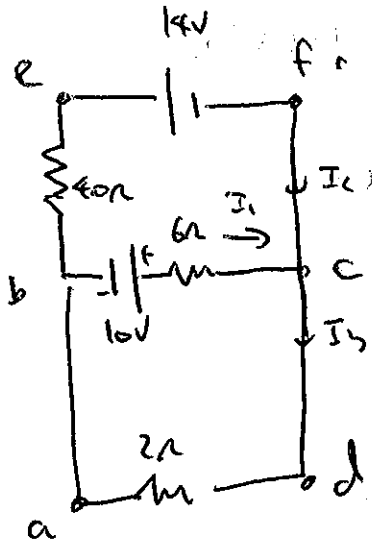
$$C\frac{dV}{dt} = \frac{V(t)}{R}$$

$$\frac{dV}{dt} = \frac{V}{RC} \qquad \frac{dV}{V} = \frac{dt}{RC}$$

$$\int \frac{dV}{V} =$$

$$V(t) = e^{-t/RC}$$

EXAMPLE



FIND I_1, I_2, I_3.

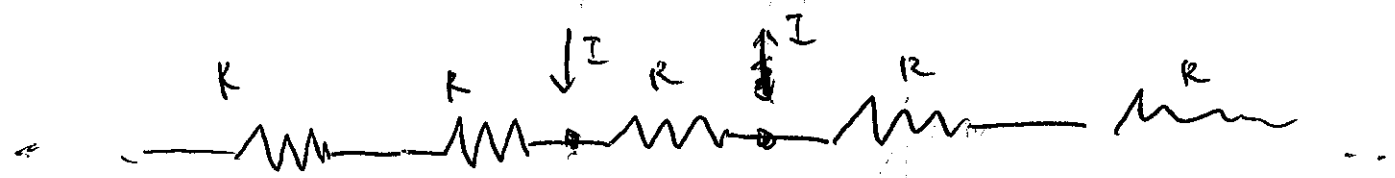
$I_1 + I_2 - I_3 = 0$ KIRCHOFF'S LAW.

FOR SET UP SEE P5

$abcda = 0 \quad +10V - I_1 6\Omega - I_3 2\Omega = 0$

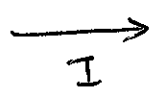
$befcb = -I_2 4 - 14V + 6 I_1 - 10V = 0$

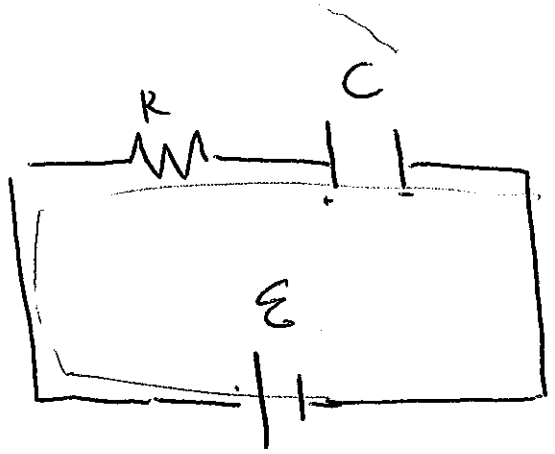
SUPER POSITION LIVES



$+I \qquad V = IR$

$R_T = 2R$





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KIRCHOFF'S LAW

$$\varepsilon - IR - \frac{q}{C} = 0$$

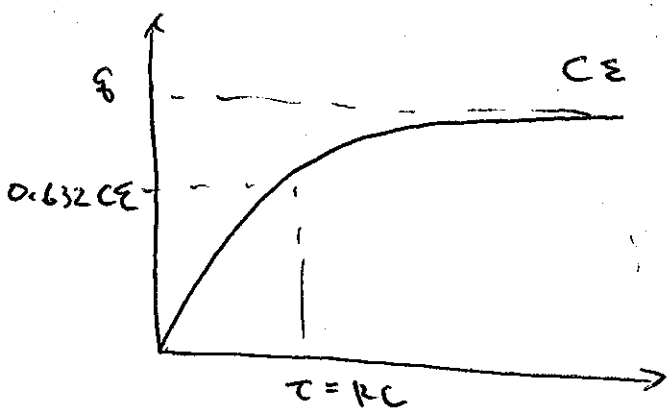
$$\varepsilon - \frac{dq}{dt}R - \frac{q}{C} = 0$$

$$\frac{dq}{dt} = \frac{\varepsilon}{R} - \frac{q}{RC}$$

$$= \frac{\varepsilon C - q}{RC}$$

$$q(t) = C\varepsilon\left(1 - e^{-t/RC}\right)$$

$$\tau = RC$$



$\tau = RC$

MONDAY EM 367 OHM'S LAW

WED EM 373 LIGHT BULBS, EM 361 HAND BATTERY

FRIDAY EM 382 DISCHARGE THRU A VOLTMETER