EECS16A DIS10A

"New" (old) setup. Technical issues. I can't be able to hear, so type in chat!

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OH: W 10AM-12PM (HWP)

Logistics

MT2 Today! Goodluck.

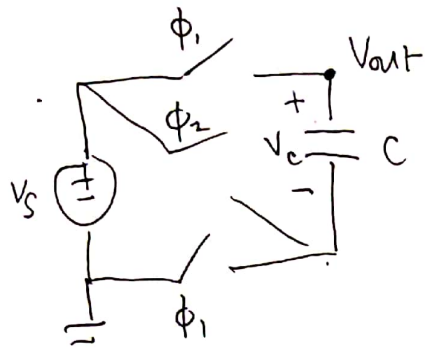
Learning Objectives

→ 25/120 ① Voltage dividers - how to choose resistors to get a design (analysis, design)

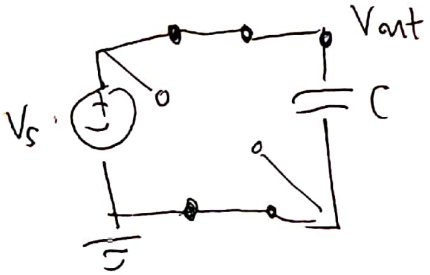
→ 49/120 ② Charge sharing example → Voltage doubler

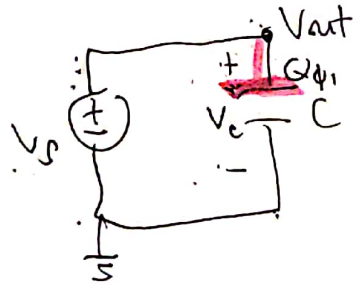
③ General Q&A

[2] Voltage booster



(a) Find V_{out} in phase ϕ_1
(ϕ_1 switches closed)
ϕ_2 switch open





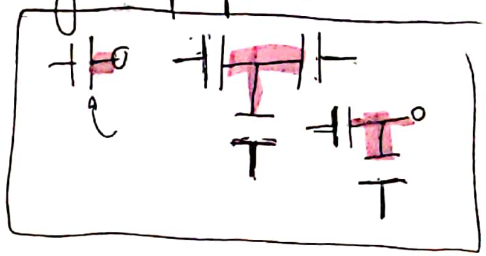
$Q_{\phi_1} = CV_c$
$= CV_s$

$V_{out} = V_s$

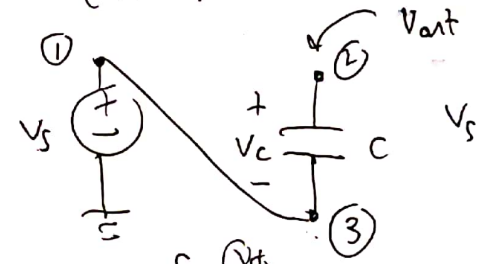
How to determine charges for charge cons.

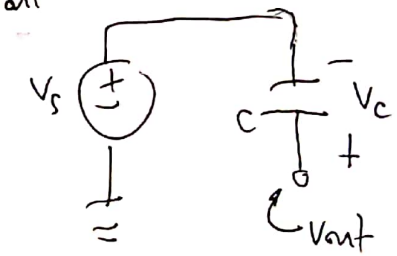
(1) Look @ a floating node in phase 2
(2) Compute the sum of charges on that node as a function of node voltages
(3) Look at charges as they started in phase 1

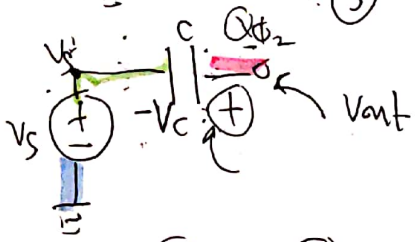
Floating node: node connected to only Cap. plates or open circuits



(b) Find V_{out} in phase ϕ_2
(ϕ_1 open, ϕ_2 closed)





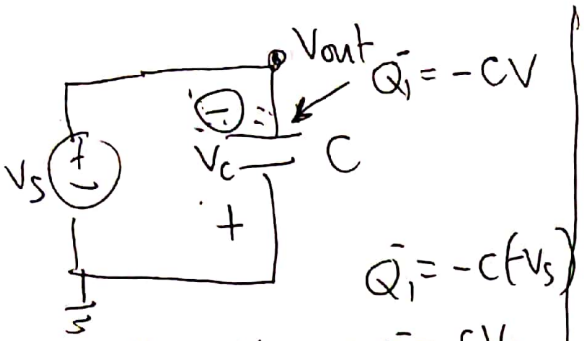


$Q_{\phi_2} = +CV_c$
$V_c = V_{out} - V_s$

$Q_{\phi_1} = Q_{\phi_2}$ (cons. of charge)

$CV_s = C(V_{out} - V_s)$ → $V_s = V_{out} - V_s$

$\boxed{V_{out} = 2V_s}$

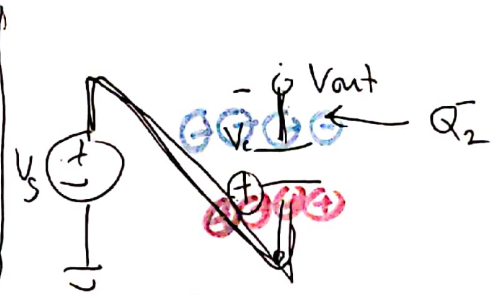


$Q_1^- = -C(V_S)$

$V_C = -V_S \Rightarrow Q_1^- = CV_S$

element voltage =

node voltage on + − node voltage on −



$Q_1^- = Q_2^-$

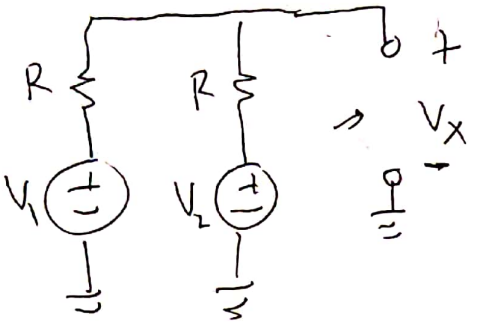
$CV_S = -CV_C$

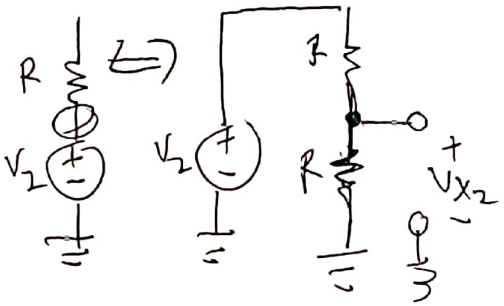
$CV_S = -C(V_S - V_{out})$

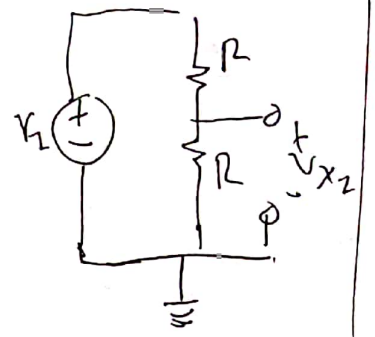
$V_S = -V_S + V_{out}$

$V_{out} = 2V_S$

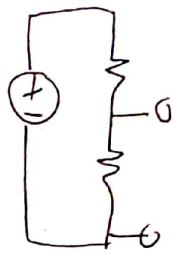
Q: How to redraw







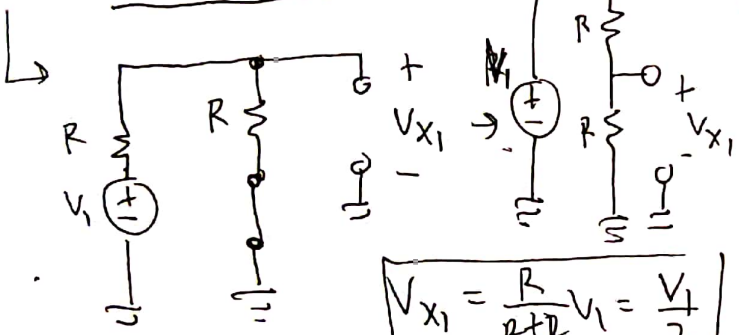
VDN



(a) Find Vx

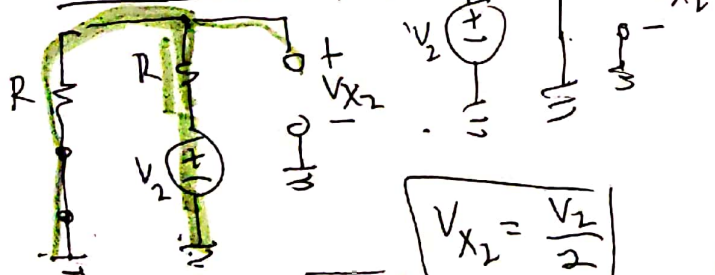
① Superposition

V_1 on, V_2 off



$$V_{x_1} = \frac{R}{R+R} V_1 = \frac{V_1}{2}$$

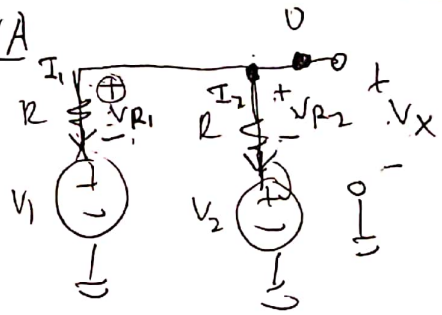
V_2 on, V_1 off



$$V_{x_2} = \frac{V_2}{2}$$

$$V_x = V_{x_1} + V_{x_2} = \frac{V_1 + V_2}{2}$$

② NVA



$$I_1 + I_2 = 0$$

$$\frac{u - V_1}{R} + \frac{u - V_2}{R} = 0$$

$$u - V_1 + u - V_2 = 0$$

$$2u = V_1 + V_2$$

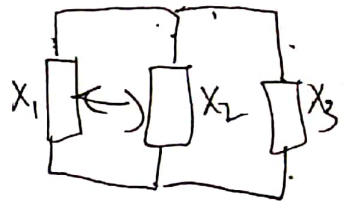
$$u = \frac{V_1 + V_2}{2}$$

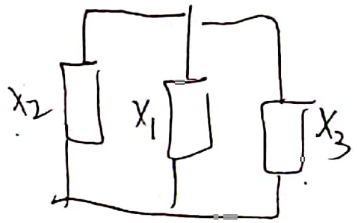
$$V_x = \frac{V_1 + V_2}{2}$$

$V_x = U - 0$

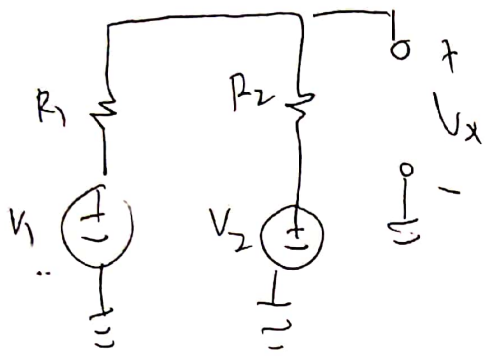
$V_x = u$

If two things are in parallel



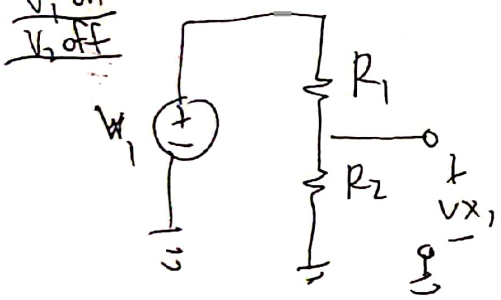


Can switch elements, doesn't change circuit



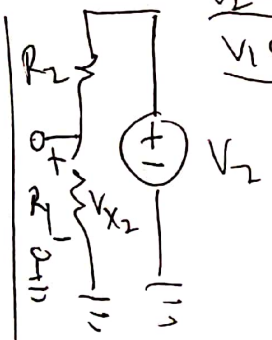
Goal: $V_x = \frac{1}{3}V_1 + \frac{2}{3}V_2$

V_1 on / V_2 off



$V_{x_1} = \frac{R_2}{R_1+R_2}V_1$

V_2 on / V_1 off



$V_{x_2} = \frac{R_1}{R_1+R_2}V_2$

$V_x = \frac{R_2}{R_1+R_2}V_1 + \frac{R_1}{R_1+R_2}V_2 = \boxed{\frac{1}{3}V_1 + \frac{2}{3}V_2}$

$\frac{R_2}{R_1+R_2} = \frac{1}{3}$, $\frac{R_1}{R_1+R_2} = \frac{2}{3}$

$R_2 = \frac{1}{3}R_1 + \frac{1}{3}R_2$

$0 = \frac{1}{3}R_1 - \frac{2}{3}R_2$

$\rightarrow R_1 = 2R_2$

$R_1 = 1k\Omega$

$R_2 = 500\,\Omega$

$R_1 = \frac{2}{3}R_1 + \frac{2}{3}R_2$

$\frac{1}{3}R_1 - \frac{2}{3}R_2 = 0$

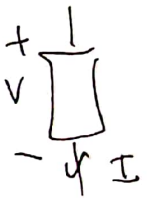
$\frac{1}{3}R_1 = \frac{2}{3}R_2$

$R_1 = 2R_2$

Power:

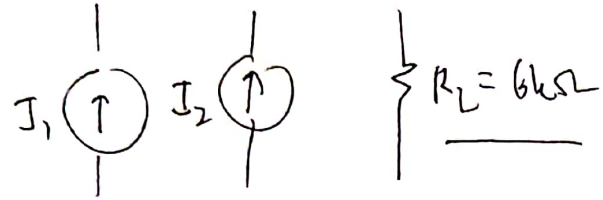
$P = IV$

element current, element voltage

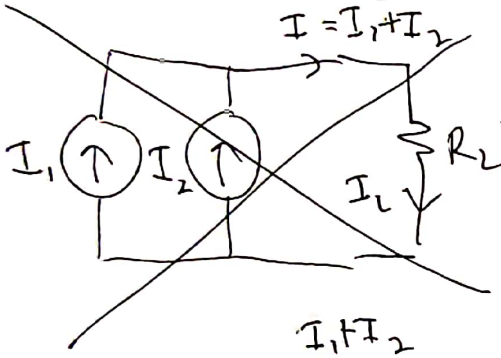


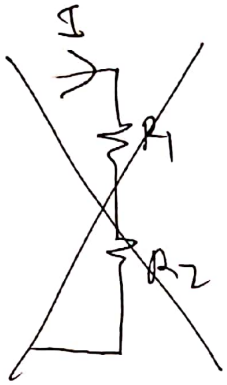
Have:

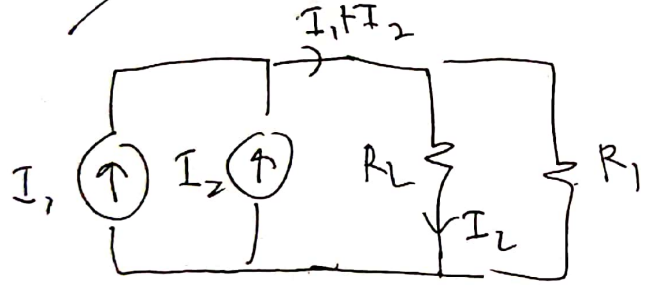
(c)



I_L (through R_L) $= \frac{2}{5}(I_1 + I_2)$







$$I_L = \frac{R_1}{R_1 + R_L}(I_1 + I_2)$$

$$\Rightarrow \frac{R_1}{R_1 + R_L} = \frac{2}{5}$$

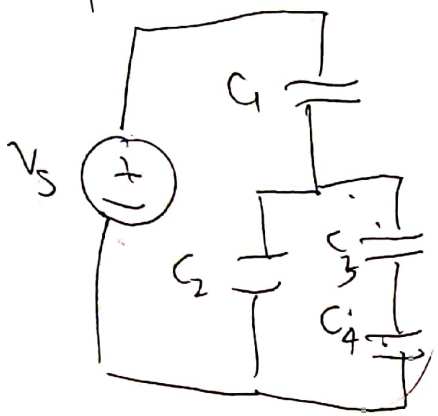
$$R_1 = \frac{2}{5}R_1 + \frac{2}{5}R_L$$

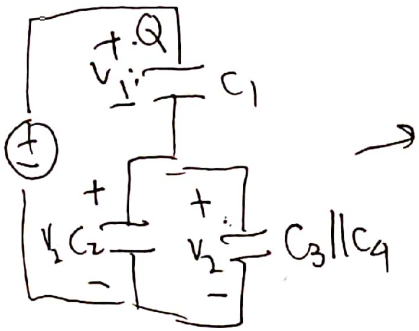
$$\frac{3}{5}R_1 = \frac{2}{5}R_L$$

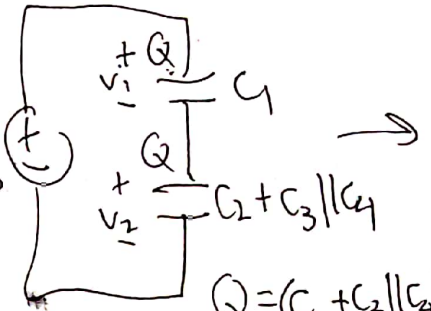
$$\boxed{R_1 = \frac{2}{3}R_L = 4k\Omega}$$

Equivalence in caps / resistors

Find all voltages + charges (assume initially all discharged)

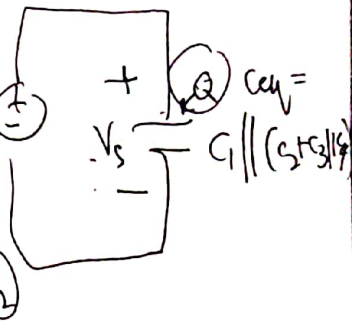






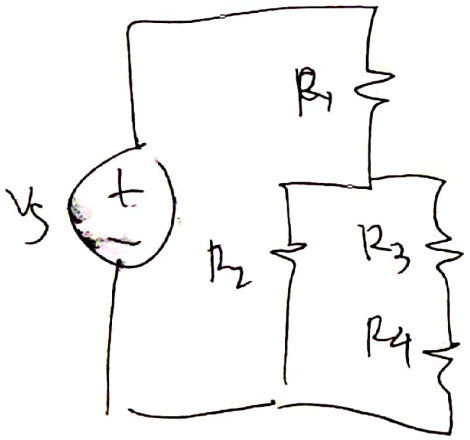
$Q = C_1 V_1$

$Q = (C_2 + C_3 || C_4) V_2$

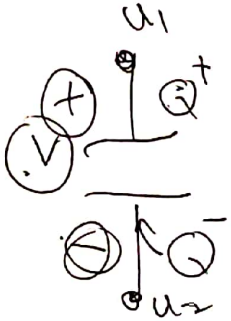


$A || B = \frac{AB}{A+B}$

Find all currents + voltages



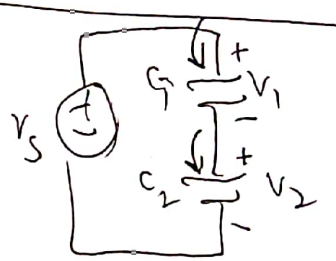
Charge on cap

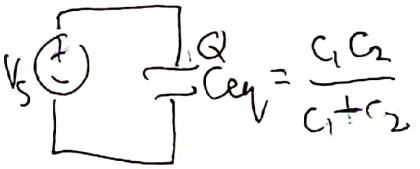


$V = u_1 - u_2$

$Q^+ = CV = C(u_1 - u_2)$

$Q^- = -CV = -C(u_1 - u_2)$





$Q = \frac{C_1 C_2}{C_1 + C_2} V_S$

$V_1 = \frac{Q}{C_1} = \frac{C_2}{C_1 + C_2} V_S$

$V_2 = \frac{Q}{C_2} = \frac{C_1}{C_1 + C_2} V_S$