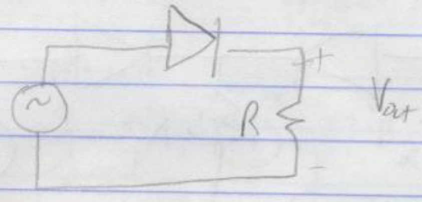
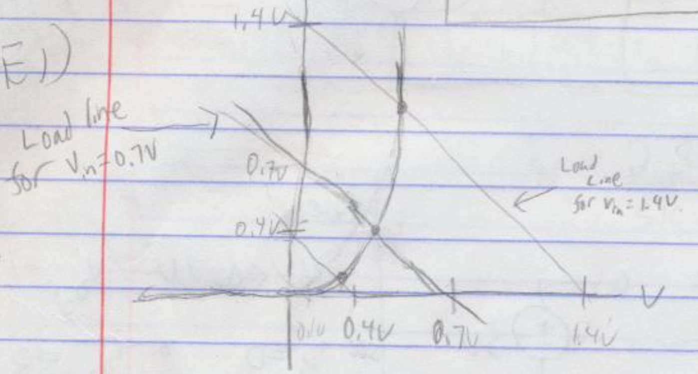
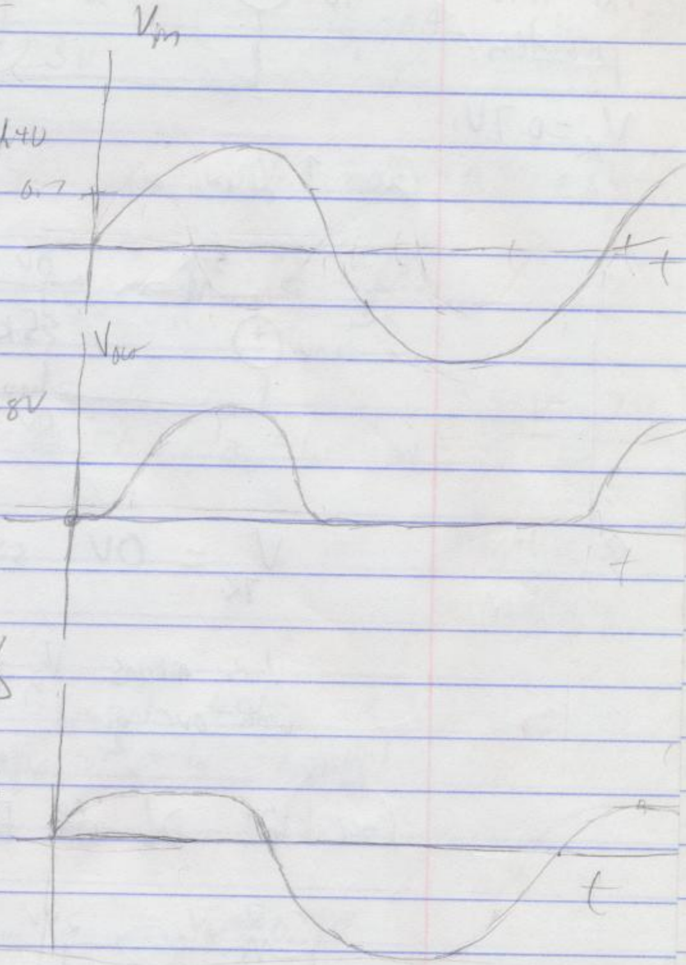
8/4/10!

$1.4 \cdot \sin(\omega t)$

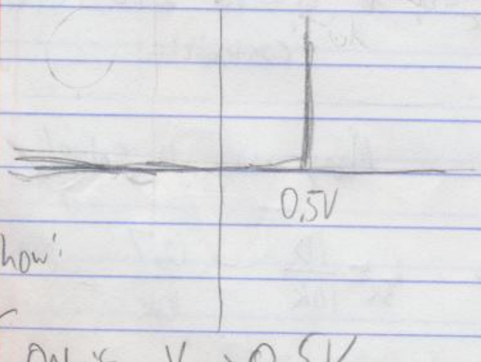


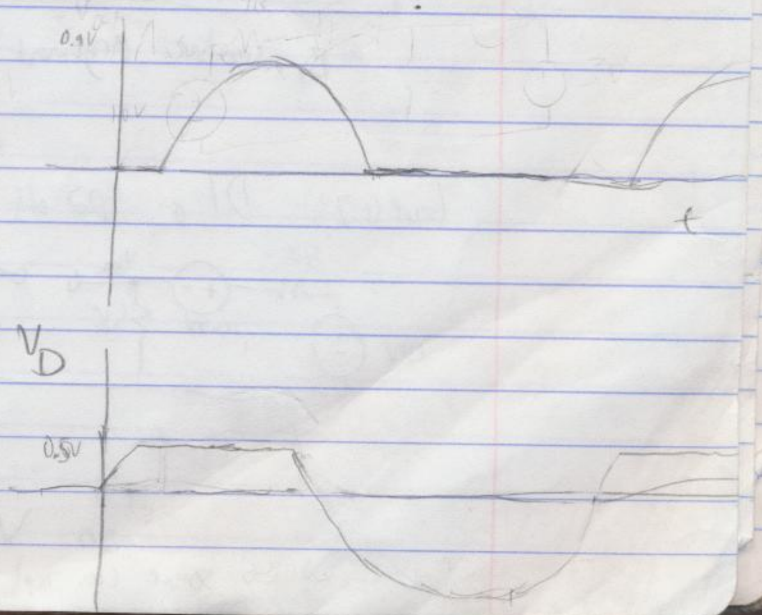

E1)




E2) w/ simple model:



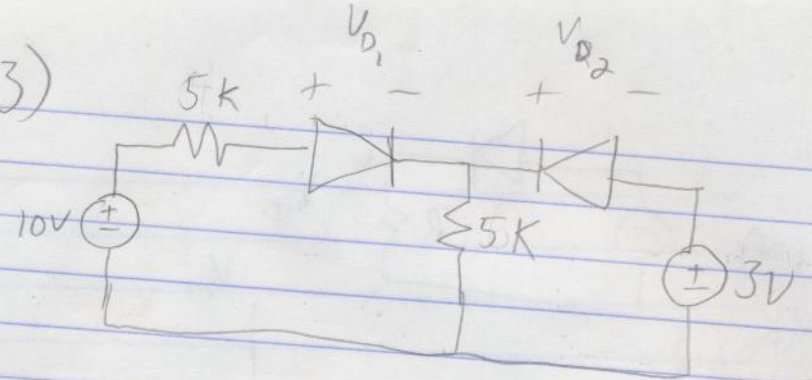

can show:

- ON if $V_{in} > 0.5V$
- OFF if $V_{in} < 0.5V$

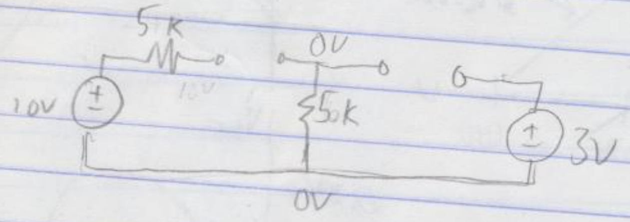
→ see webcast for details or email me and I'll write it up!

E3)

For this problem $V_K = 0.7V$.




Guess 1: Both off!




Guess:

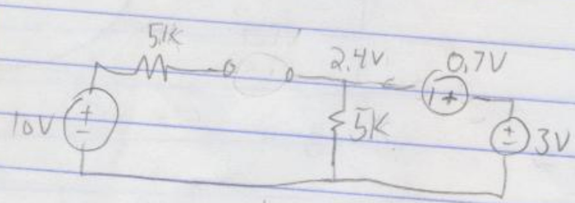
$V_{D_1} < 0.7V$ $V_{D_2} < 0.7V$

so: $i_{D_1} = 0$ so: $i_{D_2} = 0$

$V_{4k} = 0V$ since $i_{5k} = 0$.

This means $V_{D_1} = 10V$. But this is a contradiction with our guess.

Guess 2: D1 off, D2 on




Guess:

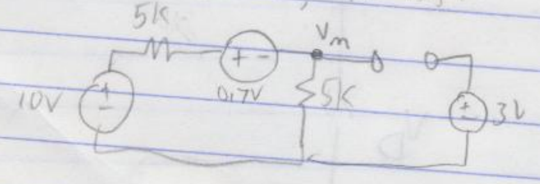
$V_{D_1} < 0.7V$ $V_{D_2} = 0.7V$

$i_{D_1} = 0$ $i_{D_2} > 0$

By similar argument $i_{4k} = 0$, so $V_{D_1} = 10 - 2.4V = 6.6V$

- contradiction!

Guess 7: D1 on, D2 off!




Many ways to solve!

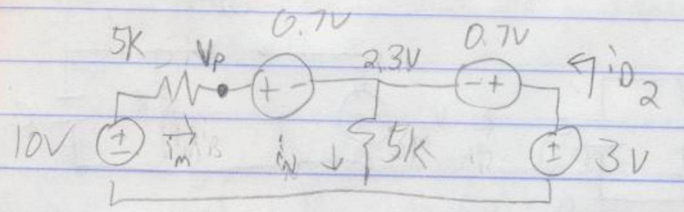
$i_{5k} = \frac{10}{10k} - \frac{0.7}{10k} = 0.93mA$

$V_m = 0.93mA \cdot 5k = 4.65V$

so $V_{D_2} = 3 - 4.65V < 0.7V$

Guess works! so we can stop!

But since we're learning, let's do the last one!




Guess!

$V_{D_1} = 0.7V$ $\quad$ $V_{D_2} = 0.7V$

$i_{D_1} > 0A$ $\quad$ $i_{D_2} > 0A$

$$i_N = \frac{2.3V}{5K} =$$

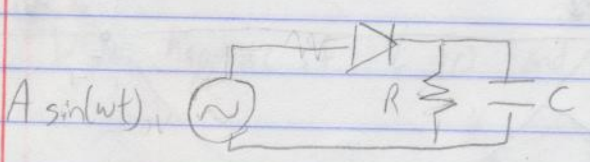
$$V_p = 2.3V + 0.7V = 3V$$

$$i_M = \frac{7V}{5K} = \quad mA$$

$$i_{D_2} + i_M = i_N \Rightarrow i_{D_2} = i_N - i_M = \frac{2.3V - 7V}{5k}$$

Negative, so contradiction!

Let's continue discussing our AC circuit. Let's see what happens if we add a capacitor in parallel with our output resistor.

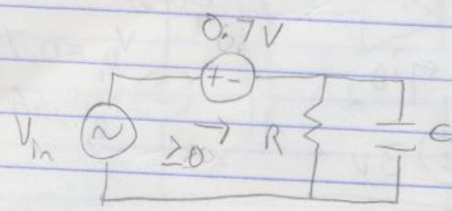



$V_K = 0.7V$

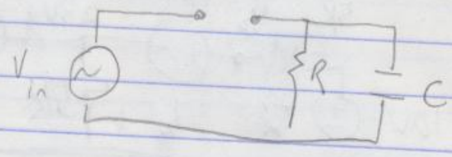
Assume $A \gg V_K$

There are 2 possible configurations.

ON:




OFF:




Requires that $i_D \geq 0$ or by KCL:

$$C \cdot \frac{d(V_{in} - 0.7V)}{dt} + \frac{V_{in} - 0.7}{R} > 0$$

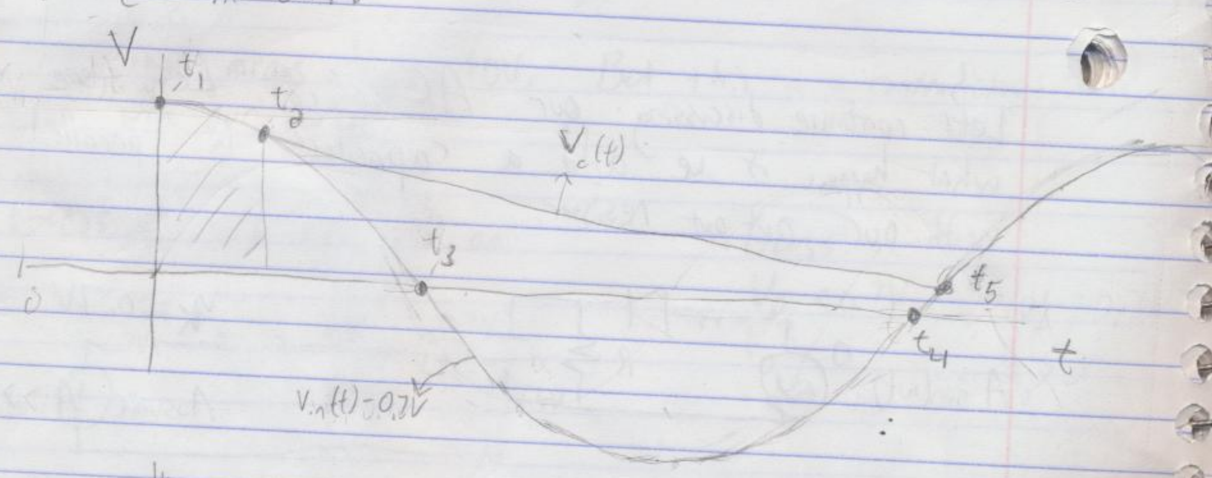
OR: $\underbrace{\frac{dV_{in}}{dt}}_{LHS} > \underbrace{\frac{0.7 - V_{in}}{RC}}_{RHS}$

In ON: $V_C = V_{in} - 0.7V$

Requires that: $V_C \geq A\sin(\omega t) - 0.7V$

In OFF:

$$V_C = V_1(e^{-t/RC})$$




At $V_1$: $\frac{dV_{in}}{dt} = 0$, $V_{in} = A$ so: $0 > \frac{0.7 - A}{RC}$ – yes, since $A \gg 0.7$

We see: In between $V_1$ and $V_3$, LHS is getting smaller and RHS is getting larger.

At $V_3$: $\frac{dV_{in}}{dt} < 0$, $V_{in} = 0$, so negative number $> \frac{0.7}{RC}$ – No!

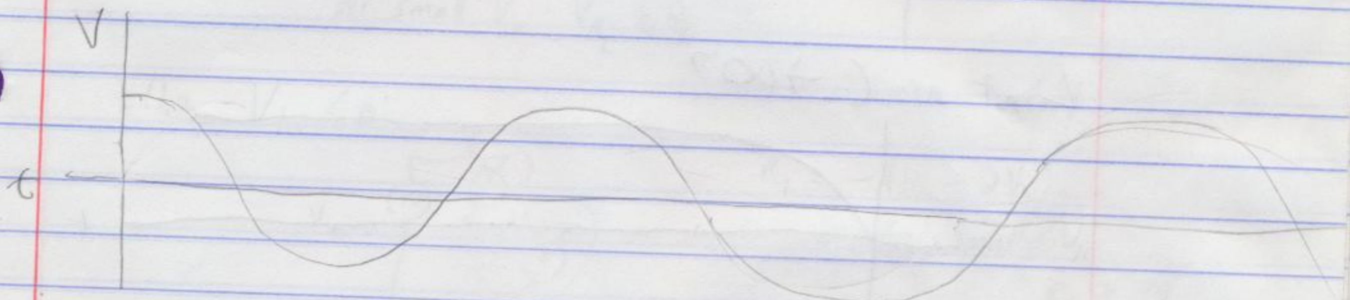
Since ON at $V_1$ and OFF at $V_3$, we know it must switch to OFF at some $V_2$.

Between $t_3$ and $t_5$, diode cannot turn on, this would violate principle that capacitor voltage can't change instantly.

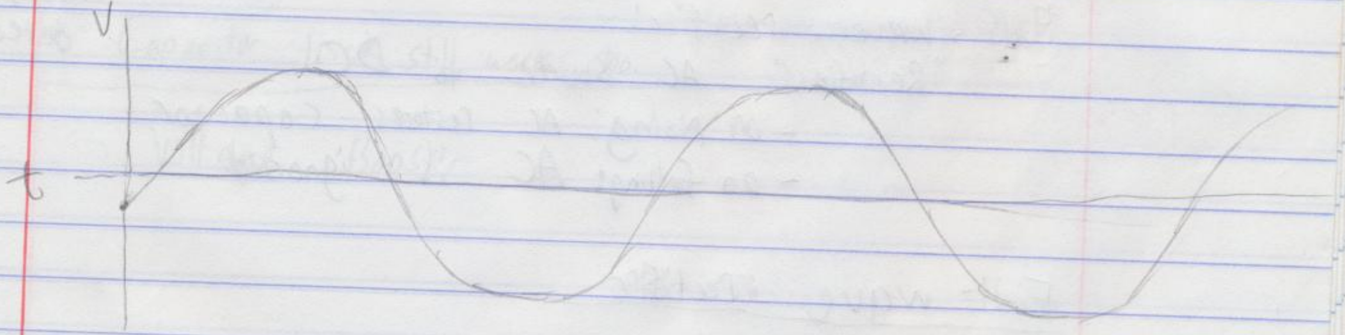
At $t_5$, diode cannot remain OFF, since this condition requires that $V_c \geq A\sin(\omega t) - 0.7V$ and if it stayed OFF it would decay below $A\sin(\omega t) - 0.7V$ which is increasing.

Thus from $t_5$ to $t_2 + T$, diode is ON, and the cycle repeats itself.

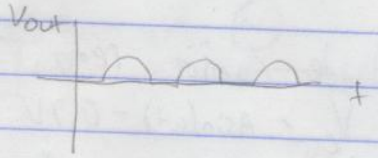
Thus it looks like:



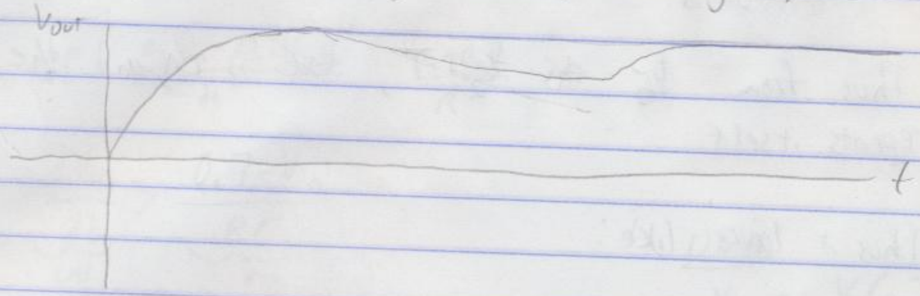

What happens if $V_c = 0$ and we start at $V_{in} = 0$.



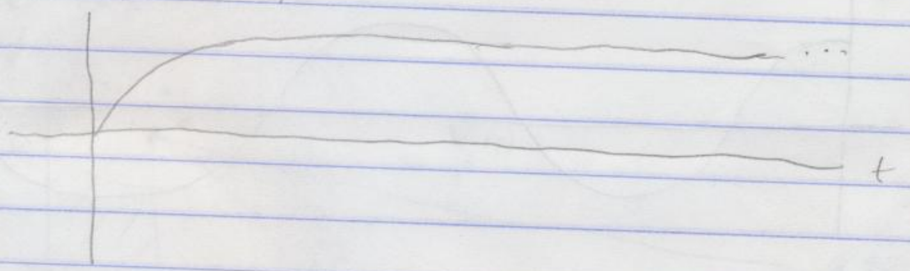
What happens as C gets very small?

Same as before: 


What happens if C gets very large?




Limit as $C \to \infty$?

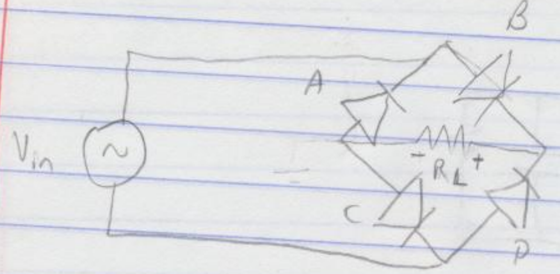



Half-wave rectifier:
"Rectifies" AC source to DC.
- on rising: AC restores capacitor
- on falling: AC is ignored.

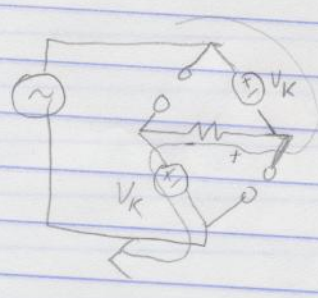
∴ Can also use as an envelope detector!

Full-wave rectifier

Assume $V_{in} >>> V_K$.



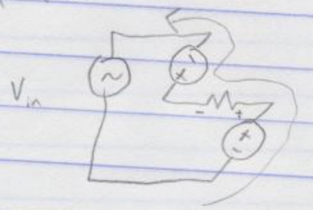

When $V_{in} > 0$,




$V_{R_L} = V_{in} - 2V_K$ or

for small $V_K$: $V_{R_L} \approx V_{in}$.

When $V_{in} < 0$:




$R_L = -(V_{in} - 2V_K)$

or for small $V_K$

$R_L \approx -V_{in}$.

So $R_L \approx |V_{in}|$

Capacitor trick still works too.

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Voltage Booster