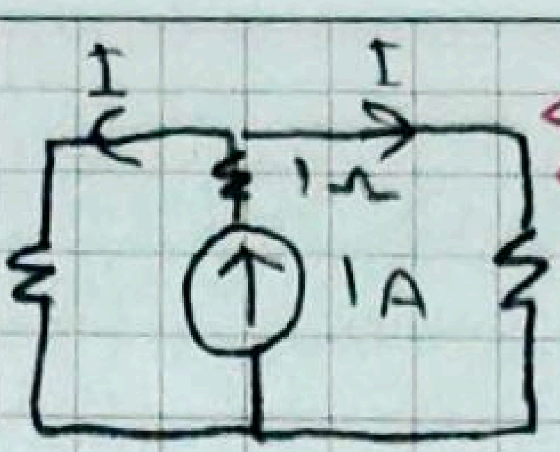
Σ32* 4 | 19F3D-0084-YUH

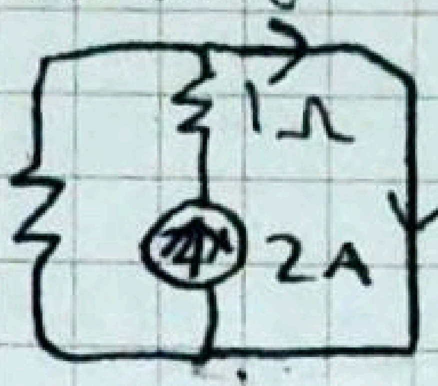
Ark 1.

1a) Superposition



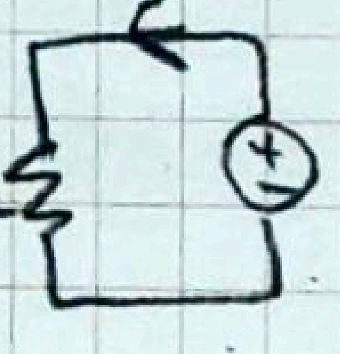
(→ 1A) nollställ övriga: 2Ω 2Ω ger $I=0,5A$

Bidrag: 0,5A riktning nedåt (spänningskälla)



(→ 2A) nollställ övriga: 4Ω ger $I=2A$

Bidrag: 2A riktning nedåt (spänninskälla)



(±) 10V nollställ övriga: 4Ω 10V $I=\frac{U}{R}$ $I=\frac{10}{4}=2,5A$

Bidrag: 2,5A riktning uppåt (spänninskälla)

Summera bidrag: $2A+0,5A-2,5A=0A$

SVAR: Strömmen genom spänninskällan är 0A

4

* Miss i svaret på 4c väger upp!

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Ark 2

1b) THe capacitors are fully charged after "a long time" - combined voltage drop: 100V

Capacitors in Parallel: $C_E = C_1 + C_2 \rightarrow 0{,}5\mu F + 0{,}3\mu F = 0{,}8\mu F$

Capacitors in Series: $C_E = \frac{C_1 \cdot C_2}{C_1 + C_2} \rightarrow \frac{0{,}2\mu F \cdot 0{,}8\mu F}{0{,}2\mu F + 0{,}8\mu F} = 0{,}16\mu F$

$V_B = 100V$ (combined voltage drop) $R = 5k\Omega$ $C = 0{,}16\mu F$ ✓

$I_C = \frac{V_B}{R} \cdot e^{\left(\frac{-t}{RC}\right)}$ $I_C = 0{,}02 \cdot e^{-800t}$ A

2

ANSWER: $I_C = 0{,}02 \cdot e^{-800t}$ A ✗

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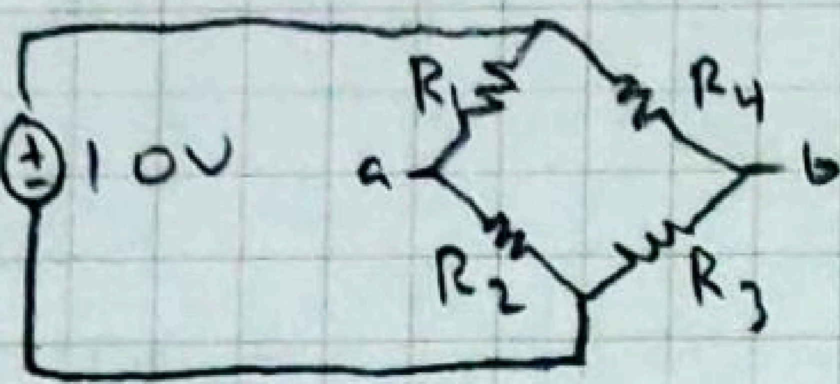
Ark 3

1c) The circuit is made up of two voltage dividers. $R_1 = R_2 = R_4 = 1\Omega$ $R_3 = 1,1\Omega$



$V_a = 10 \cdot \frac{1}{2} = 5V$ $V_b = 10 \cdot \frac{1,1}{2} = 5,5V$

$V_a - V_b = 5V - 5.5V = -0,5V$ Voltage drop $V_{ab} = 0,5V$

ANSWER: $V_{ab} = 0,5V$ X

1

$\frac{7}{9}$

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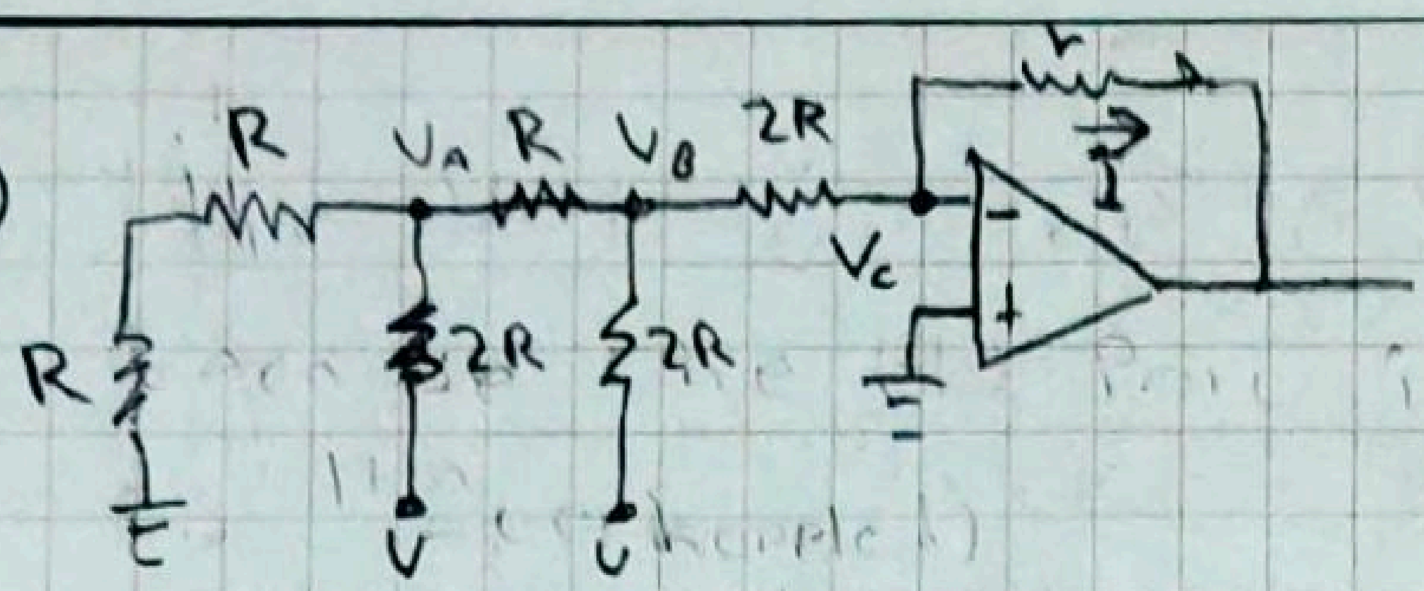
2a)



(+) Grounded and "ačrrhoppled" $V_c =$
$\rightarrow V_c = 0$

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Ark 4

Voltage divider at V_A and V_B: $V_A = V \cdot \frac{2R}{4R} = \frac{V}{2}$ $V_B = V \cdot \frac{2R}{4R} = \frac{V}{2}$

$V_A = V_B$

Current from V_B to V_C: $I = \frac{V}{R}$ $I = \frac{\frac{V}{2}}{2R} = \frac{V}{4R}$ A

No current enters OP-amp (−) Port under ideal conditions

→ Same current through resistor r.

ANSWER: $I = \frac{V}{4R}$ A ✓

5

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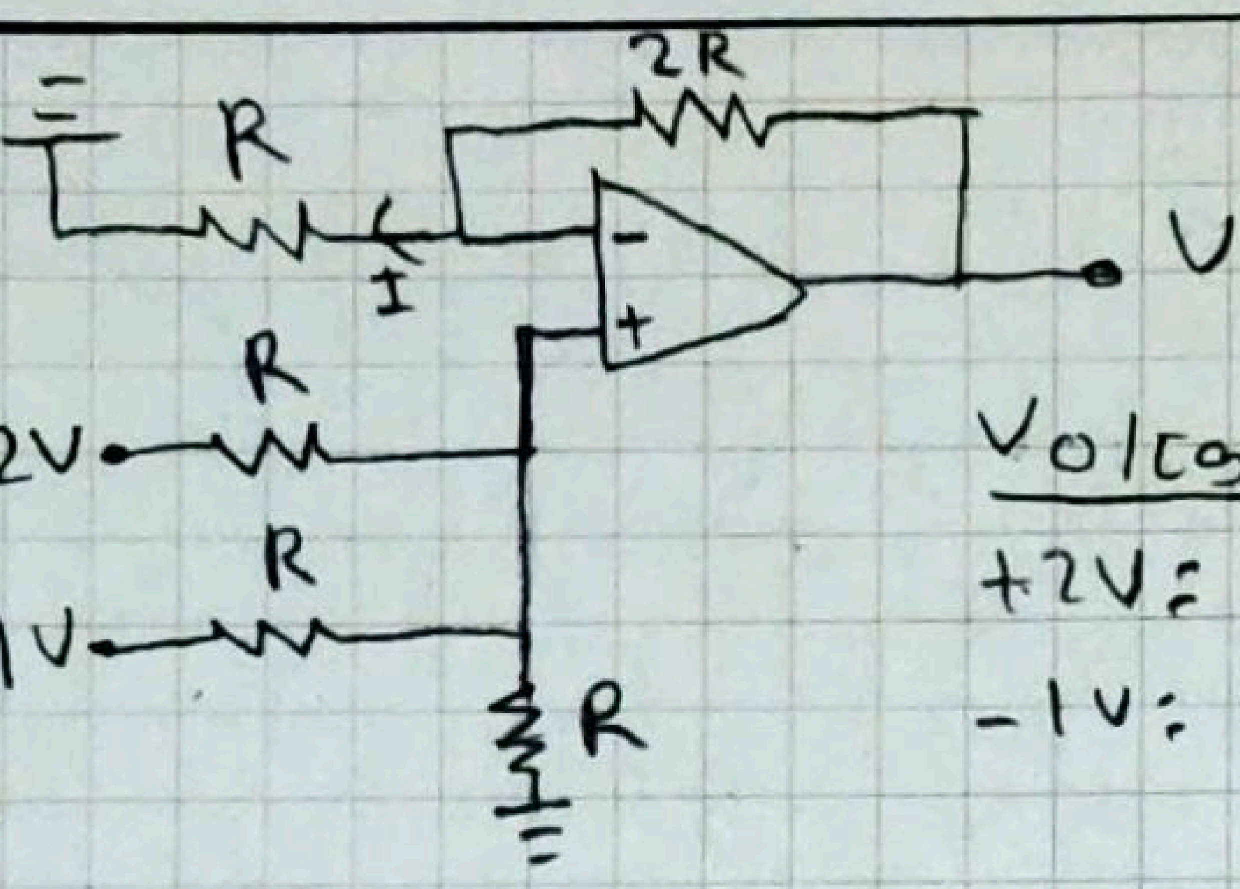
2b



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Arks

Voltage divider

+2V: $2 \cdot \frac{R}{2R} = 1V$

−1V: $-1 \cdot \frac{R}{2R} = -\frac{1}{2}V$

Sum: $1V - \frac{1}{2}V = \frac{1}{2}V$ $\quad V_+ = \frac{1}{2}V$

$U_+ = U_-$ gives current to the left over R $I = \frac{\frac{1}{2}}{R} = \frac{1}{2R} A$

$V_0 - U_- = 2R \cdot \frac{1}{2R} = 1V$ $\qquad V_0 = 1V + 0{,}5V = 1{,}5V$

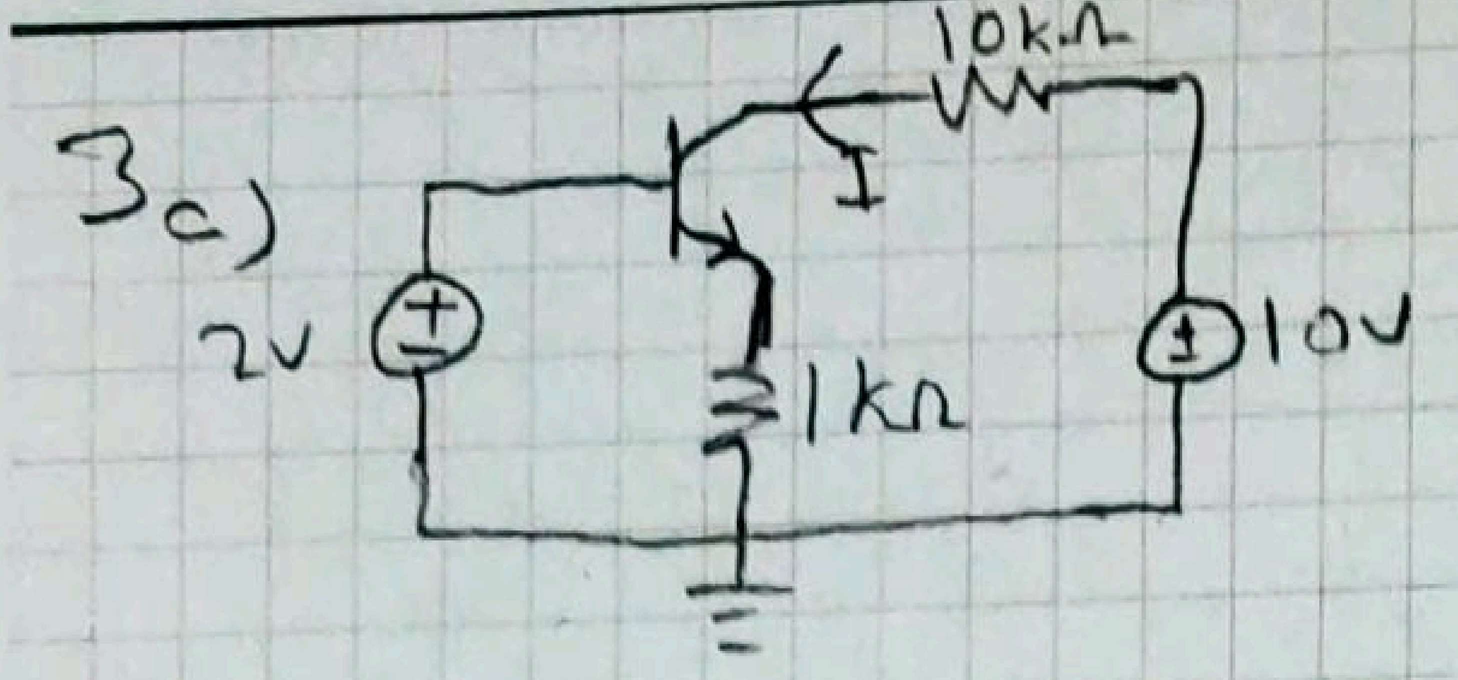
1

ANSWER: $V_0 = 1{,}5V$ (output voltage)

X

$\frac{6}{6_2}$

3a)



β (very large)

$V_{BE} = 0,7V$

$V_B = 2V$ and $V_{BE} = 0,7V$ gives $V_E = 2V - 0,7V = 1,3V$

$I = \frac{U}{R}$ $\quad I = \frac{1,3}{1k} = 1,3mA$ assuming large β $I_E \approx I_C$

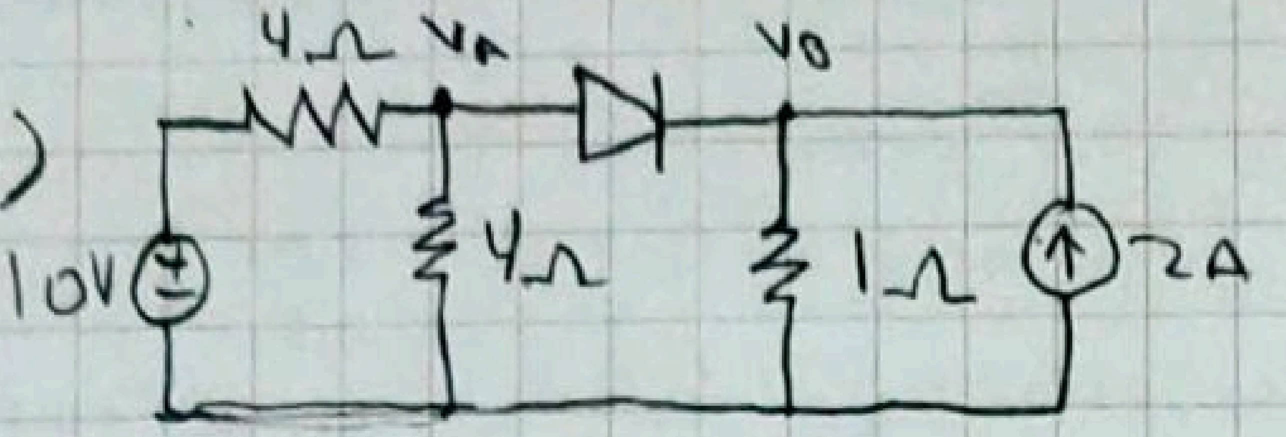
Voltage over 10kΩ resistor $U = R \cdot I$ $\quad U = 10k \cdot 1,3m = 13V$ not possible

And max I_C for active region is $\frac{U_C}{R_{Ck}} = \frac{10}{10k} = 1mA$

as $1,3mA > 1mA$ the transistor is saturated.

ANSWER: Mode of operation is "saturated"

4

3b) 

Ideal diode $V_{BE}=0V$

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Ark 7

Current through diode if Voltage is 0V or more from left to right. D|

no current through diode: $V_A = 10 \cdot \frac{4}{8} = 5V$ $V_B = 2 \cdot 1 = 2V$

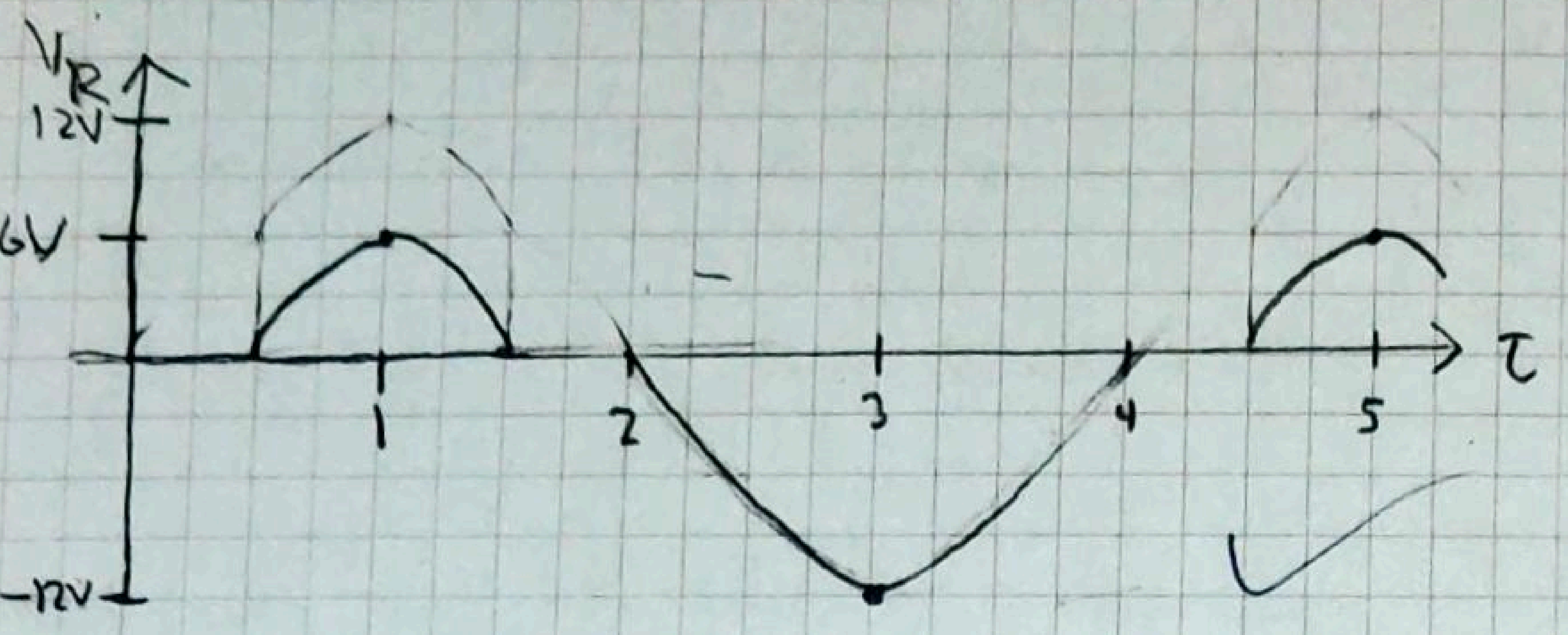
→ The diode will let through current as long as $V_A >= V_B$

Because the current through the current source results in a 2V drop across the 1ohm resistor

Those 2V will not draw any current from the 10V source

0

3c) Zener diode ideal and breakdown Voltage 6V



$12 \cdot \sin \omega t$

$\omega = \pi$ (for graphing)

2

The Voltage over the Zener diode increases, but the voltage over R does not, because 0 current is flowing. Then at breakdown Voltage current is again flowing, but the Zener diode has a Voltage drop of 6V so the Voltage U_R has its maximum at 6V (half on diode, half on resistor). When the direction is reversed the diode has $V_{BG} = 0V$ and can be neglected.

$\frac{6}{Q_3}$

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Ark 9

4a) $(X + Z(\overline{Y} + (\overline{Z} + X\overline{Y})))(\overline{X} + \overline{Z}(X+Y)) = 1$ ①

$X = 1$ gives $(1 + Z(\overline{Y} + (\overline{Z} + 1 \cdot \overline{Y})))(0 + \overline{Z}(1+Y)) = 1$

$1 + b = 1$
$1 \cdot b = b$ $\Rightarrow \overline{Z} = 1$

$Z = 0$

$X = 1$ and $Z = 0$ gives: (for ①)

$(1 + 0(\overline{Y} + (1 + 1\overline{Y})))(0 + 1(1 + Y)) = 1$

$0 \cdot b = 0$
$1 + b = 1$
$1 \cdot b = b$ $\Rightarrow 1 + Y = 1$

Y can be whatever

ANSWER: $X = 1$ and $Z = 0$, Y can be both 1 and 0

2

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Ark 10

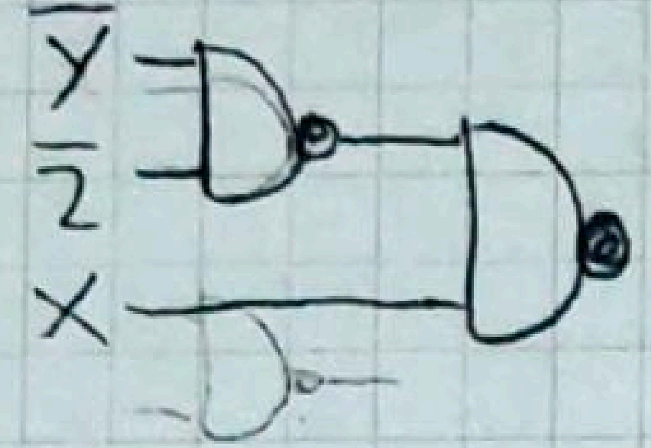
4b) $F(w,x,y,z) = wy + xy + \bar{w}xyz + \bar{w}\bar{x}y + xz + \bar{x}\bar{y}\bar{z}$

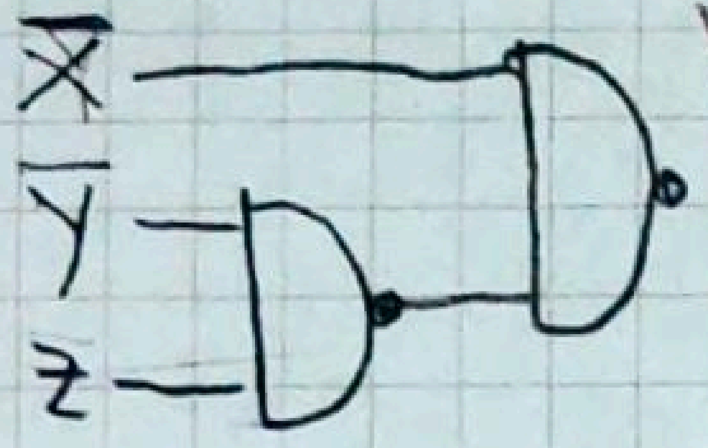
WX \ YZ	00	01	11	10
00	1	0	1	1
01	0	1	1	1
11	0	1	1	1
10	1	0	1	1

3 Circled groups of 2^n

1. XZ
2. $\bar{X}\bar{Z}$
3. Y

4 YX





2

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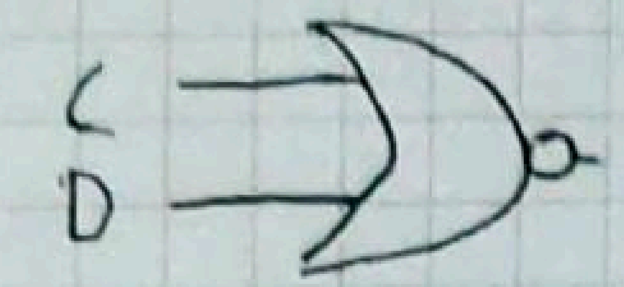
Ark 11

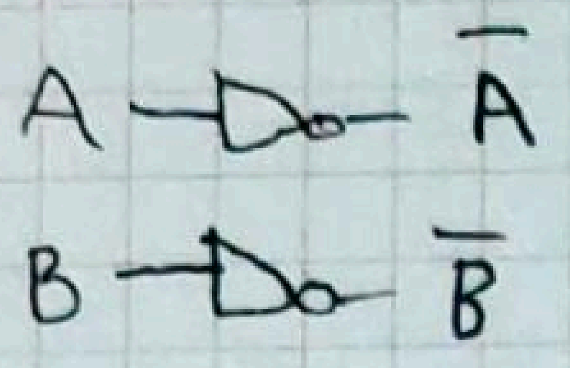
4c) $Y = AB + \bar{C}\bar{D}$



$\Leftrightarrow$

C	D	OUT
0	0	1
0	1	0
1	0	0
1	1	0

$\Leftrightarrow \bar{C}\bar{D}$



$\bar{A}$	$\bar{B}$	desired
0	0	1
0	1	0
1	0	0
1	1	0

$\Rightarrow$ Gate G1 = NOR $\Leftrightarrow AB$ R

R

and then gate G2 = OR $\Leftrightarrow AB + \bar{C}\bar{D}$

ANSWER: G1 = NOR and G2 = NOR ???

1

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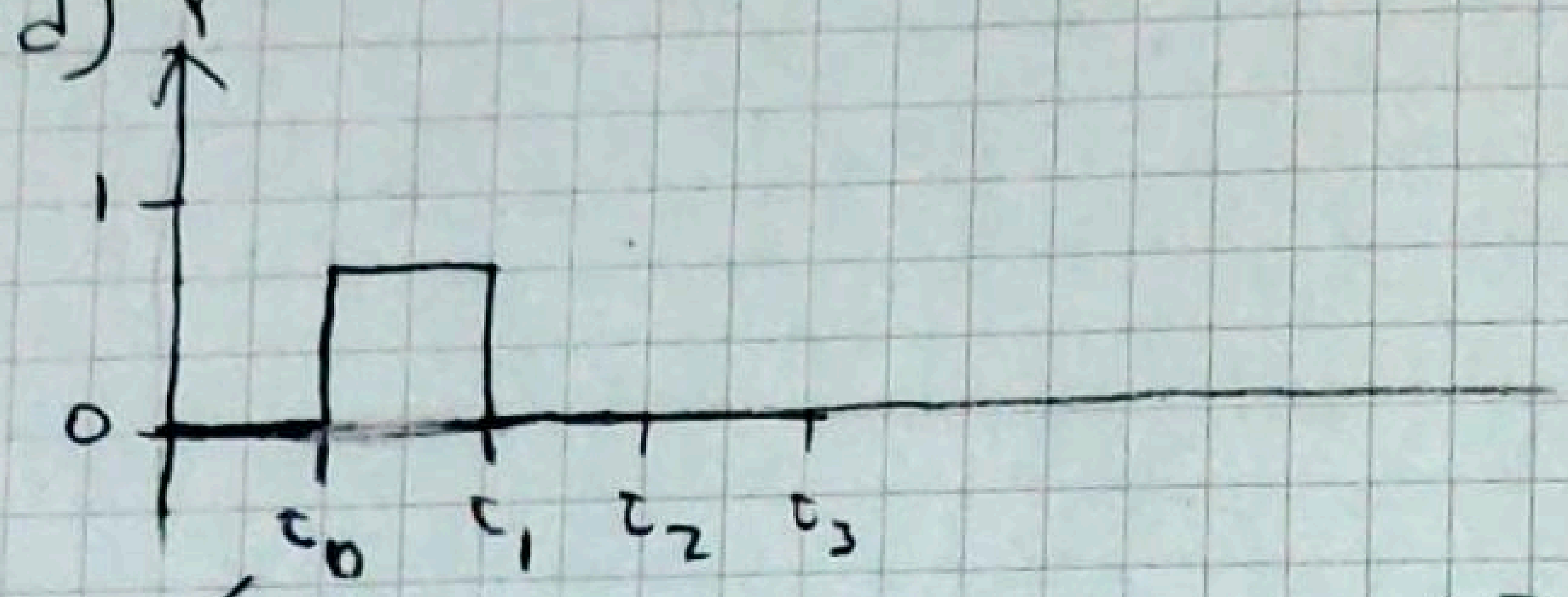
Ark 12

4d) 

t_0 First clk $Q_1 = 1$ and $Q_2 = 1$ ($\bar{Q}_1$ is first on 1)

t_1 Second clk $Q_1 = 1$ and $Q_2 = 0$ ($\bar{Q}$ changed last clk)

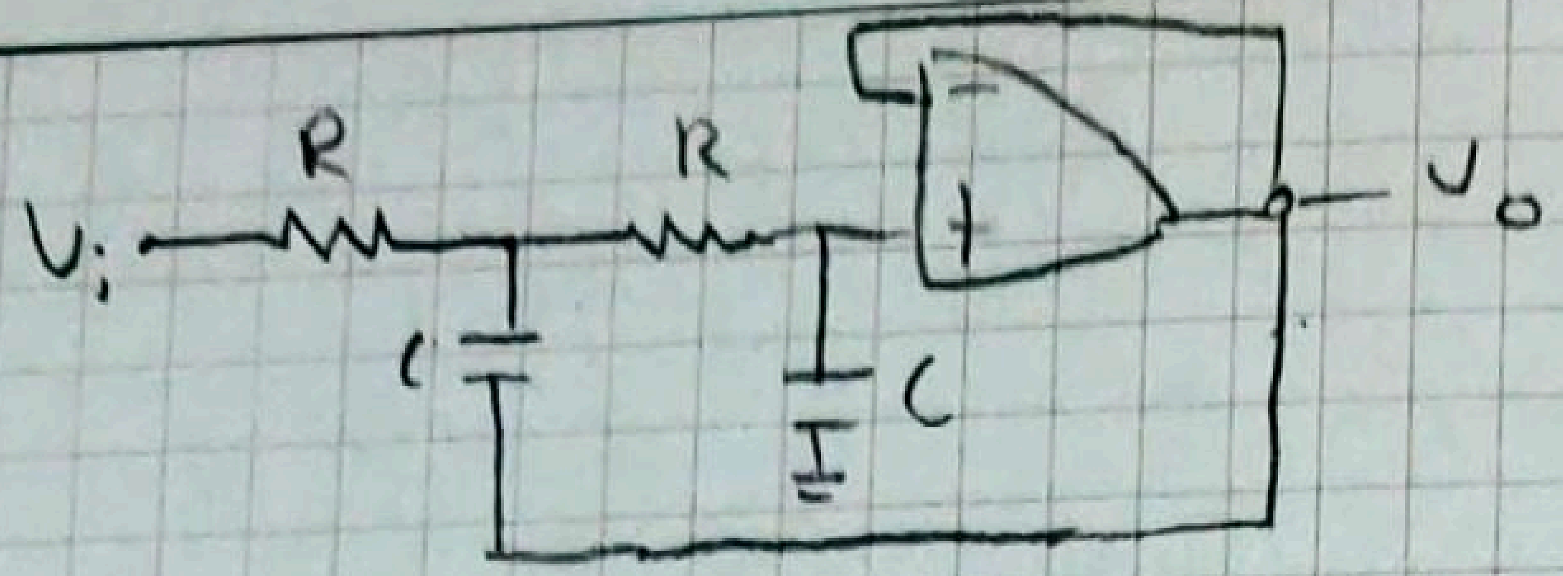
t_2 Third clk $Q_1 = 1$ and $Q_2 = 0$ ($\bar{Q}$ still 0)

t_3 Fourth clk $Q_1 = 1$ and $Q_2 = 0$ ($\bar{Q}$ still 0)

3

$\Sigma 8$

5a)



First we decermine the trensfer funccion $H(jw) = \frac{V_o}{V_{in}}$

$$V_{in} = Z_R + Z_R + Z_c = 2R + \frac{1}{jwc} \quad \text{series capacitors}$$

$$V_{ut} = Z_c + Z_R + Z_c = R + \frac{jwc - jwc}{jwc + jwc} = R + \frac{jwc}{2}$$

$$H(jw) = \frac{R + \frac{jwc}{2}}{2R + \frac{1}{jwc}} = \frac{R \cdot jwc - \frac{1}{2}w^2c^2}{2Rjwc + 1}$$

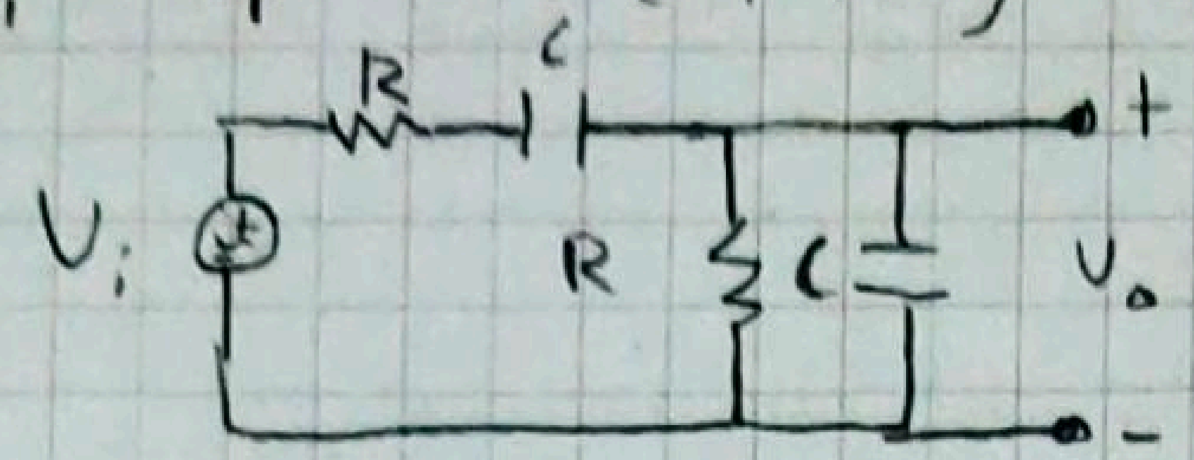
Extreme values $w \to 0$ an $w \to \infty$:

$$\lim_{w \to 0} H(jw) = 0 \qquad \lim_{w \to \infty} H(jw) = -\frac{c^2}{4Rjc} = -\frac{c}{4Rj}$$

⇒ Highpass filter

ANSWER: It is a Highpass filter circuit.

5b) $V_i = V_p \cos(t/RC)$ determine V_o



Transfer function: $H(j\omega) = \frac{V_o}{V_i}$

$$V_i = (Z_R + Z_C + Z_R \,||\, Z_C) I = \left(R + \frac{1}{j\omega C} + \frac{R}{Rj\omega C + 1}\right) I$$

$$V_o = Z_R \,||\, Z_C I = R \,||\, \frac{1}{j\omega C} I = \frac{\frac{R}{j\omega C}}{R + \frac{1}{j\omega C}} \cdot I = \frac{R}{Rj\omega C + 1} \cdot I$$

$$H(j\omega) = \frac{\frac{R}{Rj\omega C+1}}{R + \frac{1}{j\omega C} + \frac{R}{Rj\omega C+1}} = \frac{R}{R(Rj\omega C+1) + \frac{Rj\omega C+1}{Rj\omega C} + R} = \frac{R^2 j\omega C}{R^2 j\omega C(Rj\omega C+1) + Rj\omega C + 1 + R^2 j\omega C}$$

$$= \frac{R^2 j\omega C}{-R^3\omega^2C^2 + 2R^2 j\omega C + Rj\omega C + 1}$$

Jag har redan dragit poäng för detta i 5a) => 5

Σ5