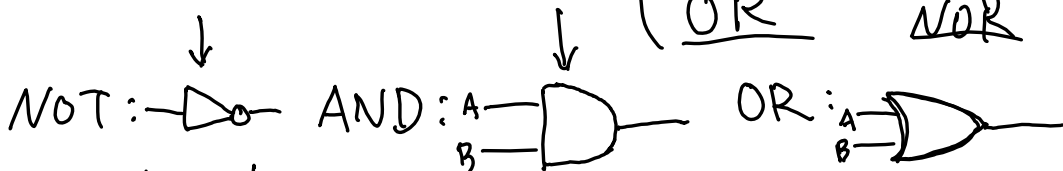


HW 6

1. a & b

Hint: assume that $\begin{cases} \text{NOT} & \text{gates} \\ \text{AND} & \text{NAND} \\ \text{OR} & \text{NOR} \end{cases}$ are given.



in	out
0	1
1	0

(1x pMOS, 1x nMOS)

A	B	out
0	0	0
0	1	0
1	0	0
1	1	1

(3x pMOS, 3x nMOS)

A	B	out
0	0	0
0	1	1
1	0	1
1	1	1

(3x pMOS, 3x nMOS)

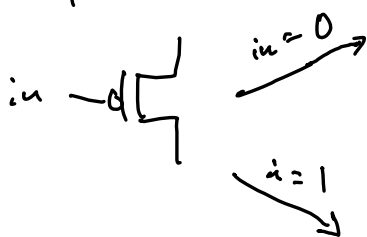
XOR:

A	B	out
0	0	0
0	1	1
1	0	1
1	1	0

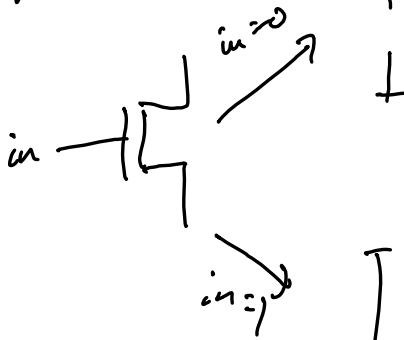
XNOR:

A	B	out
0	0	1
0	1	0
1	0	0
1	1	1

pMOS: in = 0 → 1



nMOS: in = 0 → 0



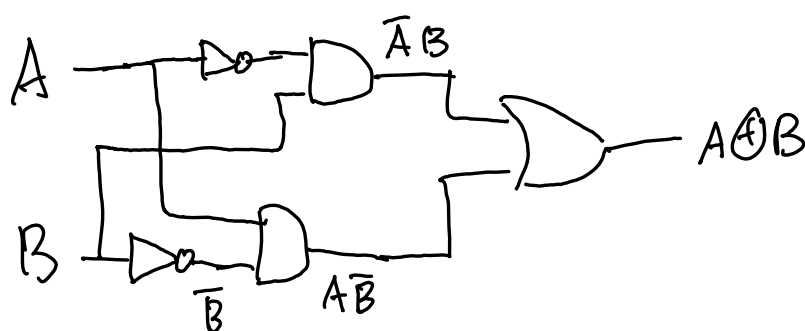
inputs A, B:

AND → $A \cdot B$ $A \cap B$

NOT → $\bar{A}$, A'

OR → $A + B$.

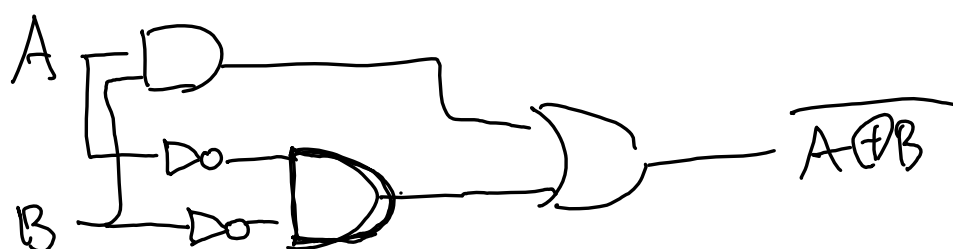
$$\text{XOR: } A \oplus B = \underline{\underline{A \cdot \bar{B} + \bar{A} \cdot B}}$$



2x AND, 2x NOT, 1x OR
6 2 6

$$6 \cdot 2 + 2 \cdot 2 + 6 = 22 \text{ transistors.}$$

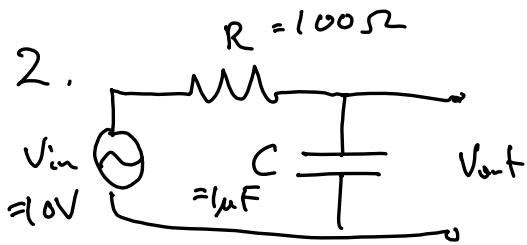
$$\text{XNOR: } \underline{\underline{AB + \bar{A}\bar{B}}}$$



2x AND, 1x OR, 2x NOT

$$6 \cdot 2 + 1 \cdot 6 + 2 \cdot 2 = 22 \text{ transistors.}$$

12 6 4



a) low-pass filter.

b) X_c , Z_{tot} , I & V_{out}

a) $f = 100\text{Hz}$

$$X_c = \frac{1}{2\pi f C} = \frac{1}{2\pi \cdot 100\text{Hz} \cdot 1\mu F} = \boxed{1592\Omega}$$

$$Z_{tot} = \sqrt{X_c^2 + R^2} = \sqrt{1592^2 + 100^2} = \boxed{1595\Omega}$$

$$V_{out} = V_{in} \cdot \frac{X_c}{Z_{tot}} = 10V \cdot \frac{1592}{1595} = \boxed{9.98V}$$

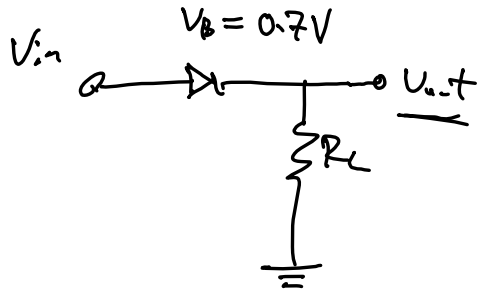
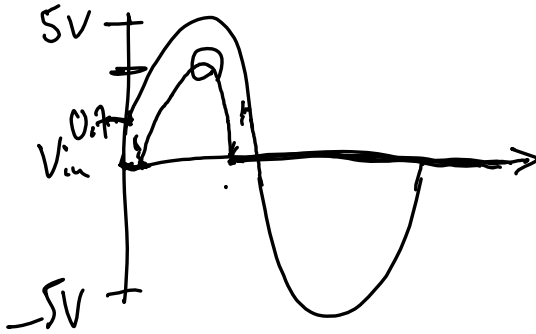
$$I = \frac{V}{Z_{tot}} = \frac{10V}{1595\Omega} = \boxed{6.27\text{mA}}$$

3. a) high-pass filter

b) same as 2



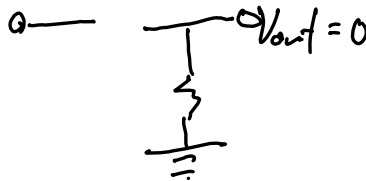
4.



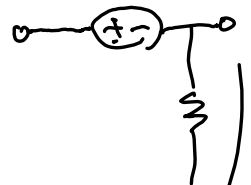
$$V_{peak} = 5V - 0.7V$$

$$= 4.3V$$

$$V_{in} < 0.7V$$



$$V_{in} \geq 0.7V:$$

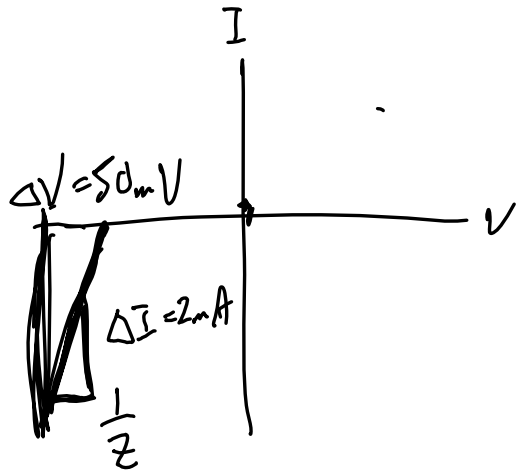


$$V_{out} = V_{in} - 0.7V$$

S. Zener diodes

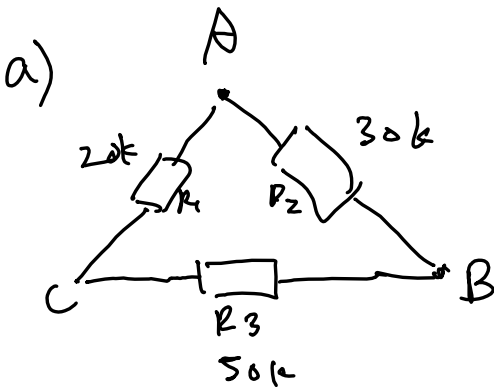
$$\Delta V = 50 \text{ mV}$$

$$\Delta I = 2 \text{ mA}$$



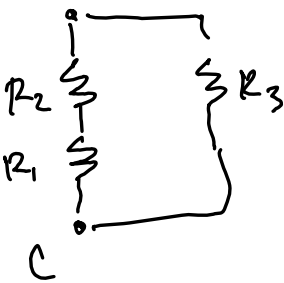
$$Z = \frac{\Delta V}{\Delta I} = \frac{50 \text{ mV}}{2 \text{ mA}} = \boxed{25 \Omega}$$

6.



i. B & C

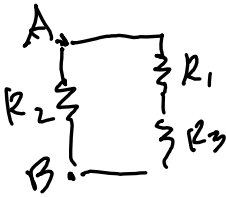
$$R_{BC} = (R_1 + R_2) \parallel R_3$$



$$= \frac{(R_1 + R_2) R_3}{R_1 + R_2 + R_3}$$

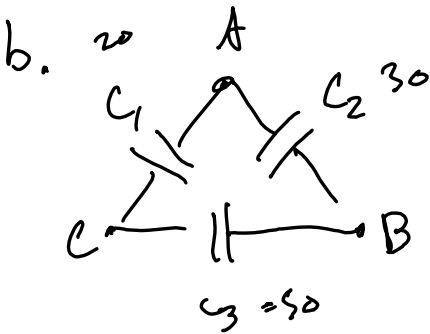
$$= \boxed{25 \text{ k}\Omega}$$

ii. A & B

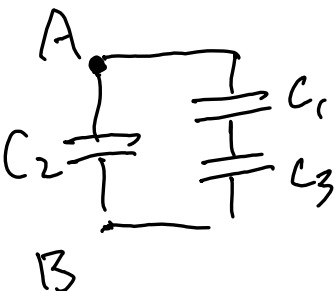


$$R_{AB} = R_2 \parallel (R_1 + R_3)$$

$$= \boxed{21 \text{ k}\Omega}$$



A & B

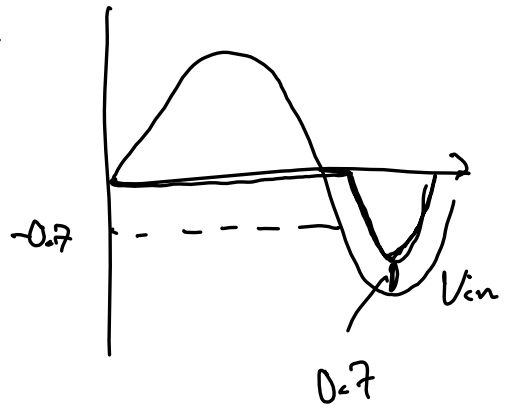
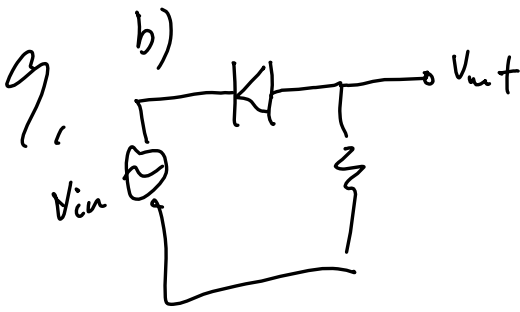


$$C_{AB} = C_2 \parallel C_3$$

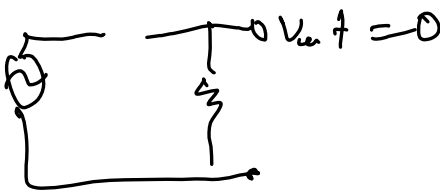
$$= \frac{C_1 C_3}{C_1 + C_3}$$

$$C_{AB} = C_2 + C_{13}$$

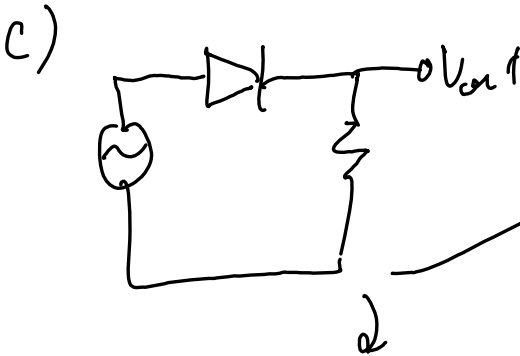
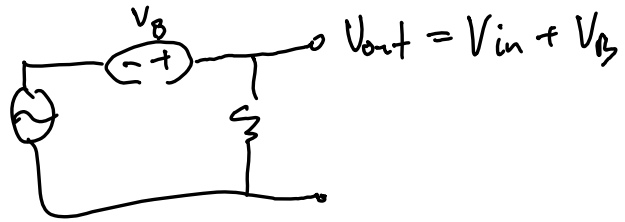
$$= C_2 + \frac{C_1 C_3}{C_1 + C_3} = \boxed{44.3 \mu\text{F}}$$



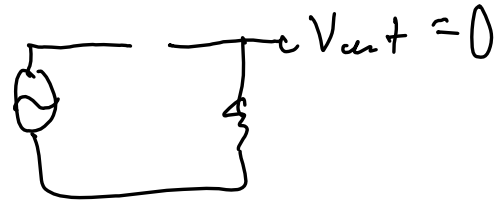
$V_{in} > -0.7V :$



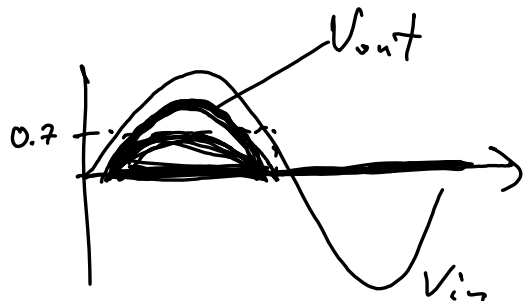
$V_{in} < -0.7V :$



$V_{in} < 0.7V :$



$V_{in} > 0.7V :$



d) same as HW5 problem 3