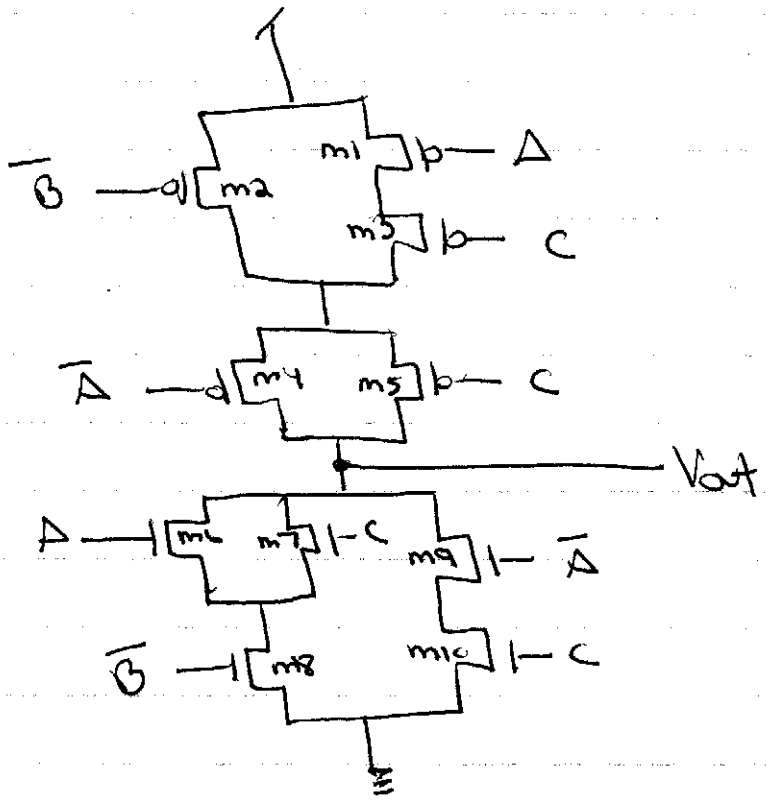
HW 4 Solutions

Problem 1:



A	B	C	m1	m2	m3	m4	m5	m6	m7	m8	m9	m10	Vout
0	0	0	on	off	on	off	on	off	off	on	on	off	Vdd → 1
0	0	1	on	off	off	off	off	off	on	on	on	on	gnd → 0
0	1	0	on	on	on	off	on	off	off	off	on	off	Vdd → 1
0	1	1	on	on	off	off	off	off	on	off	on	on	gnd → 0
1	0	0	off	off	on	on	on	on	off	on	off	off	gnd → 0
1	0	1	off	off	off	on	off	on	on	on	off	on	gnd → 0
1	1	0	off	on	on	on	on	on	off	off	off	off	Vdd → 1
1	1	1	off	on	off	on	off	on	on	off	off	on	Vdd → 1

Find the final function in SOP form:

3 possible methods

(i) n network:

$$V_{out} = \overline{(A+C)\bar{B} + \bar{A}C}$$

$$= \overline{A\bar{B} + \bar{B}C + \bar{A}C}$$

$$= (\bar{A}+B)(B+\bar{C})(A+\bar{C})$$

$$= (\bar{A}B + B + \bar{A}\bar{C} + B\bar{C})(A+\bar{C})$$

$$= (\bar{A}\bar{C} + B\bar{C} + B)(A+\bar{C})$$

$$= \bar{A}A\bar{C} + AB\bar{C} + AB + \bar{A}\bar{C}\bar{C} + B\bar{C}\bar{C} + B\bar{C}$$

$$= AB\bar{C} + AB + \bar{A}\bar{C} + B\bar{C}$$

$$\boxed{V_{out} = AB + \bar{A}\bar{C} + B\bar{C}}$$

(ii) p network:

$$V_{out} = (\bar{A}\bar{C} + B)(A+\bar{C})$$

$$= \bar{A}\bar{C}A + AB + \bar{A}\bar{C}\bar{C} + B\bar{C}$$

$$\boxed{V_{out} = AB + \bar{A}\bar{C} + B\bar{C}}$$

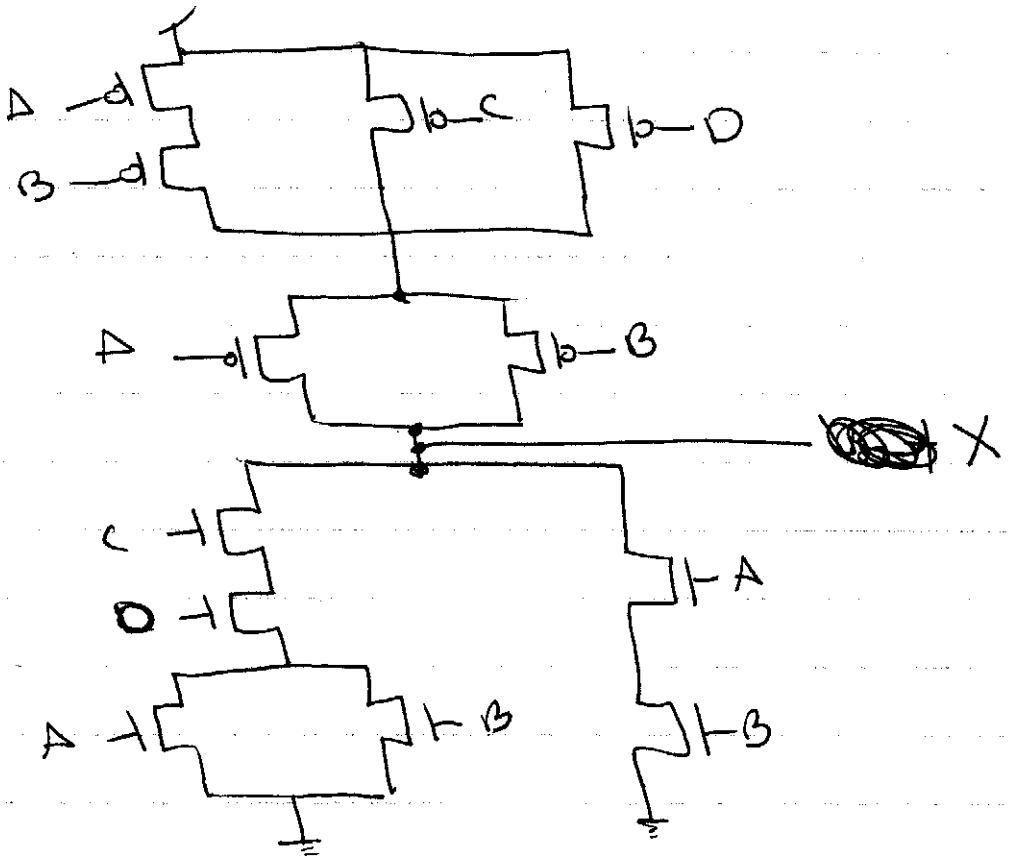
(iii)

A \ BC	00	01	11	10
0	1	0	0	1
1	0	0	1	1

$$\boxed{V_{out} = AB + B\bar{C} + \bar{A}\bar{C}}$$

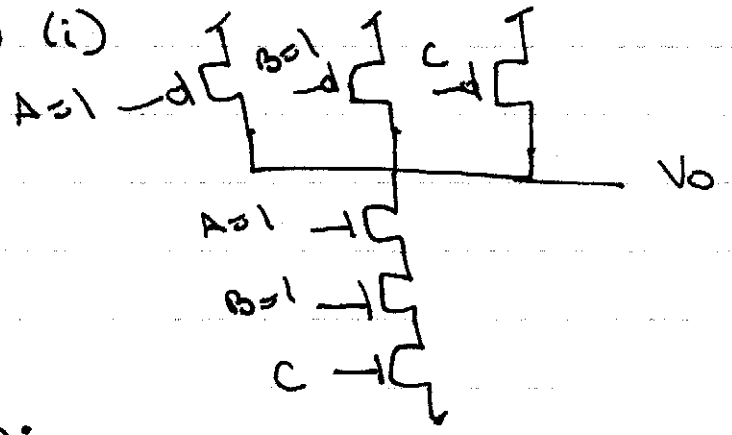
Problem 2:

$$X = \overline{(A+B)(C+D) + AB}$$

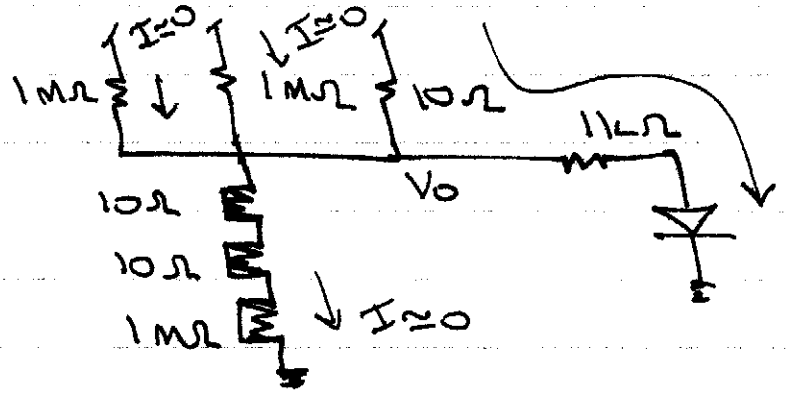


Problem 3:

a) (i)



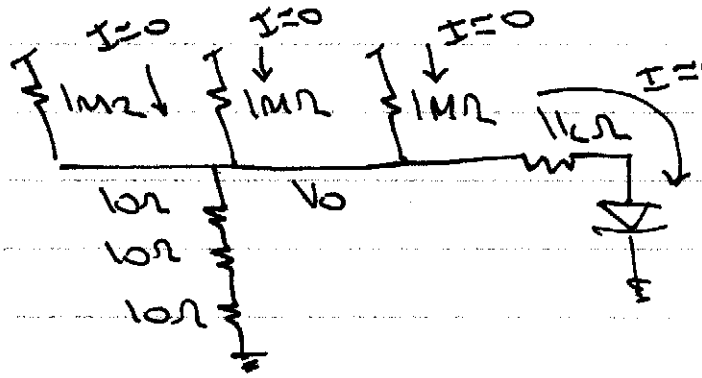
C=0:



Vo is close to VDD, so diode is forward biased

$$V_{OH} = V_{DD} - 10\Omega\left(\frac{V_{DD}}{1k\Omega+10\Omega}\right) = \boxed{4.95V = V_{OH}}$$

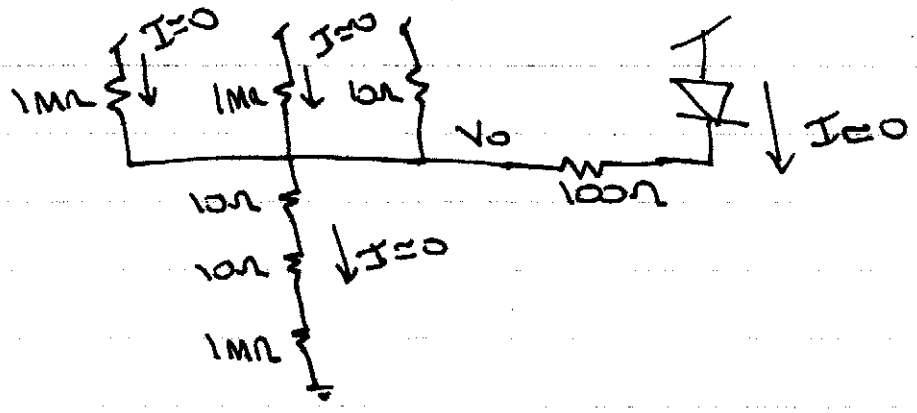
C=1:



Vo is low, so diode is ~~reverse~~ biased off

no I onto Vo, so $\boxed{V_{OL} \simeq 0V}$

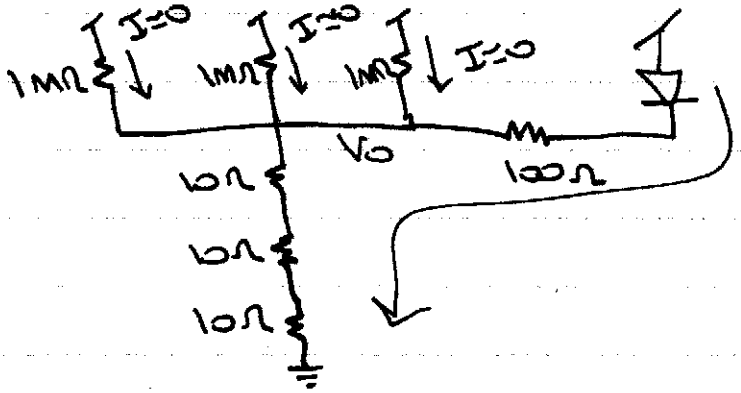
(i) C=0



Vo is high, so diode is off.

no I off Vo, so $V_{OH} \approx V_{DD} = 5V$

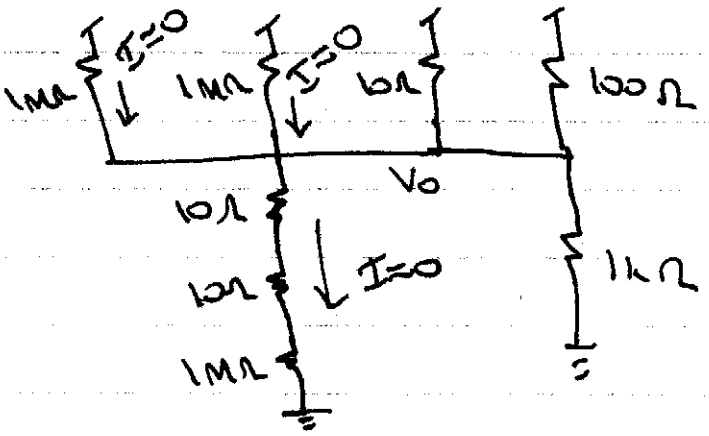
(ii) C=1



Vo is low, so diode is on

$V_{OL} \approx 30\Omega \left(\frac{V_{DD}}{100\Omega + 30\Omega}\right) =$ 1.15V = V_{OL}

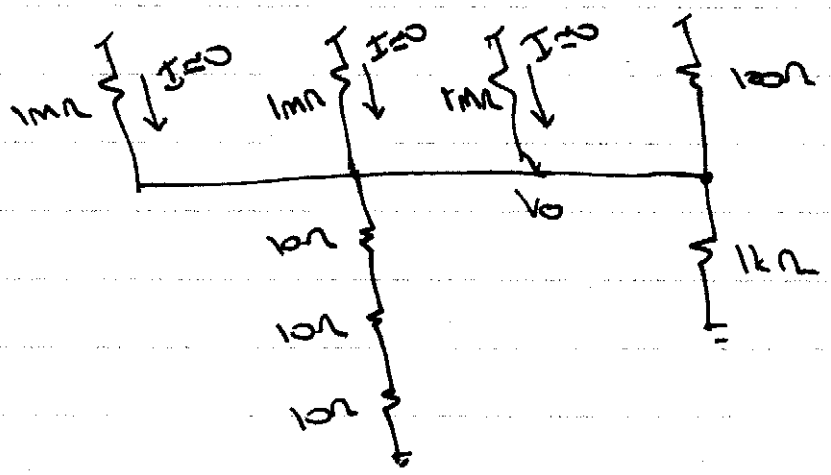
(iii.a) $C=0$



$$V_{OH} \simeq V_{DD} - \frac{V_{DD}(10\Omega \,||\, 100\Omega)}{(10\Omega \,||\, 100\Omega) + 1k\Omega}$$

$$\boxed{V_{OH} \simeq 4.95V}$$

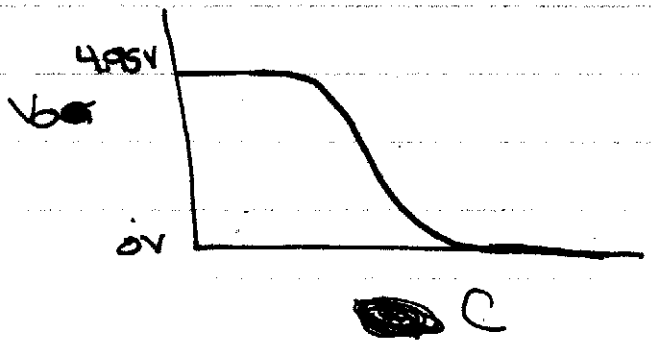
$C=1$



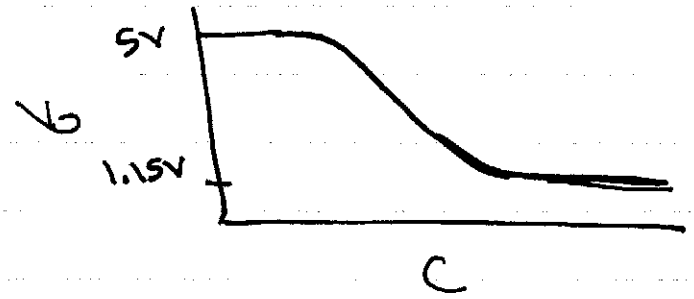
$$V_{OL} \simeq (30\Omega \,||\, 1k\Omega)\left[\frac{V_{DD}}{(30\Omega \,||\, 1k\Omega) + 100\Omega}\right]$$

$$\boxed{V_{OL} \simeq 1.13V}$$

b) (i)



(ii)



(iii)