Q1

Find binary equivalents of the following decimal numbers (in 2's complement)

a) $9.2_{10} = ?$ b) $-12.7_{10} = ?$

a) $9_{10} = 01001$ (is correct!)

$0.2 \Rightarrow$

0.4	0
0.8	0
1.6	1
1.2	1
0.4	0

$= \overline{0011}$

$9.2_{10} = 01001.\overline{0011}_2$

b) $-12.7 = -13 + 0.3$

$-13 = -(01101_2) = 2\text{'s complement}\{01101_2\}$

$= 10011$

$0.3 \Rightarrow$

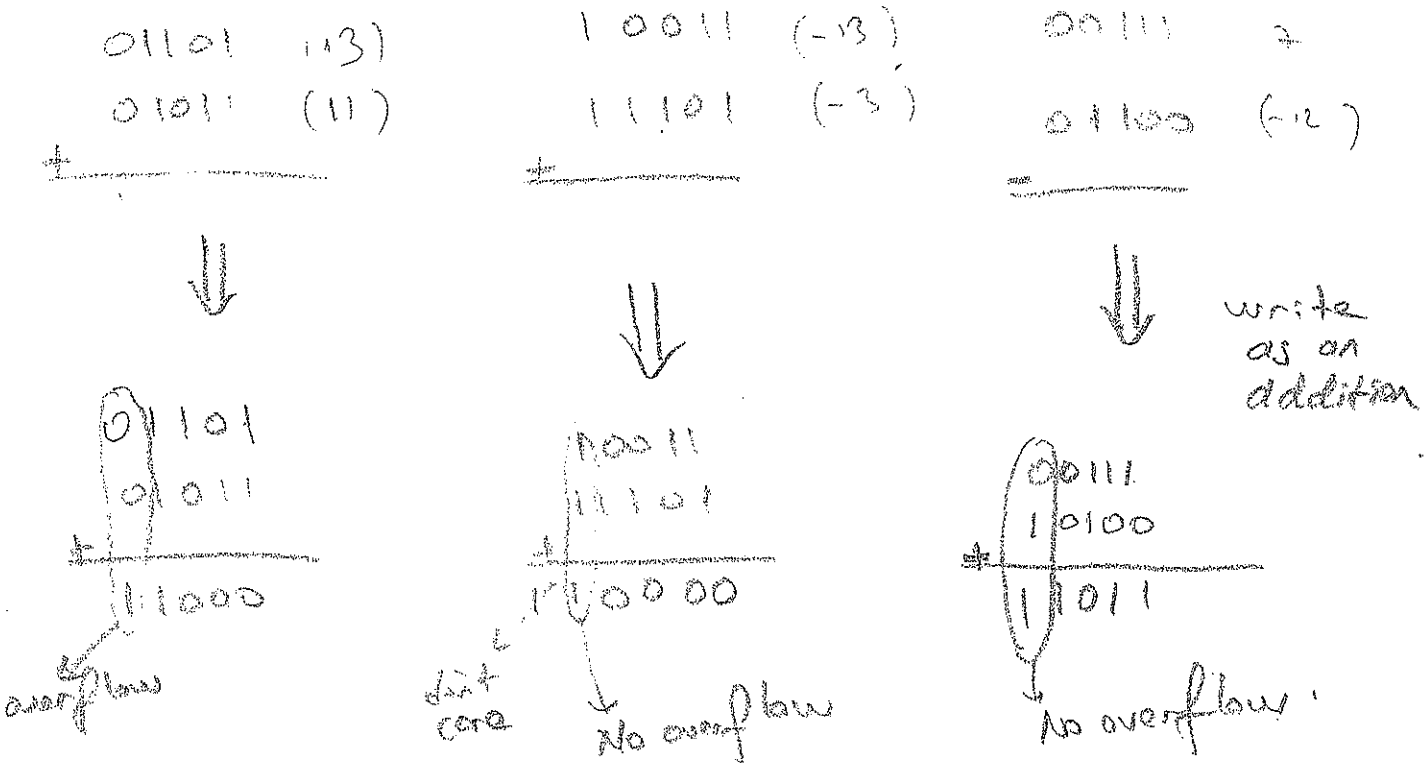
0.6	0
1.2	1
0.4	0
0.8	0
1.6	1

$= 0\overline{1001}$

$-12.7 = 10011.0\overline{1001}_2$

Q2

Do the calculations for the binary numbers given in 2's complement form. State whether there is an overflow or not.



SoP? PoS?

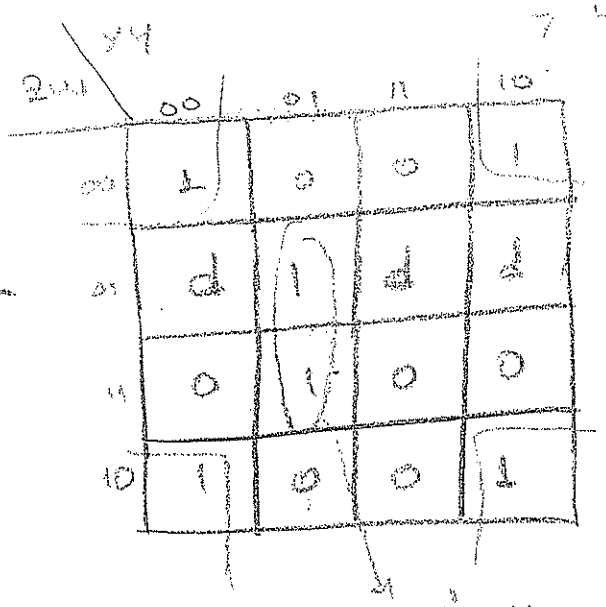
Prime implicant of a logic function $f(x_1, \dots x_n)$ is a normal product term $P(x_1, x_2, \dots x_n)$ that implies f, i.e.

$\forall (x_1, \dots x_n)$ such that $P(x_1, \dots x_n) = 1 \Rightarrow f(x_1, \dots x_n) = 1$

Distinguished 1-cell of a logic function is an input comb. that is covered by only one prime implicant.

Essential prime imp of a logic function is a prime implicant that covers one or more distinguished 1 cells.

SOP



$x'yw$ $\quad F = y'w' + x'yw$

- Minimal sum $\Rightarrow$ sum of prime implicants.

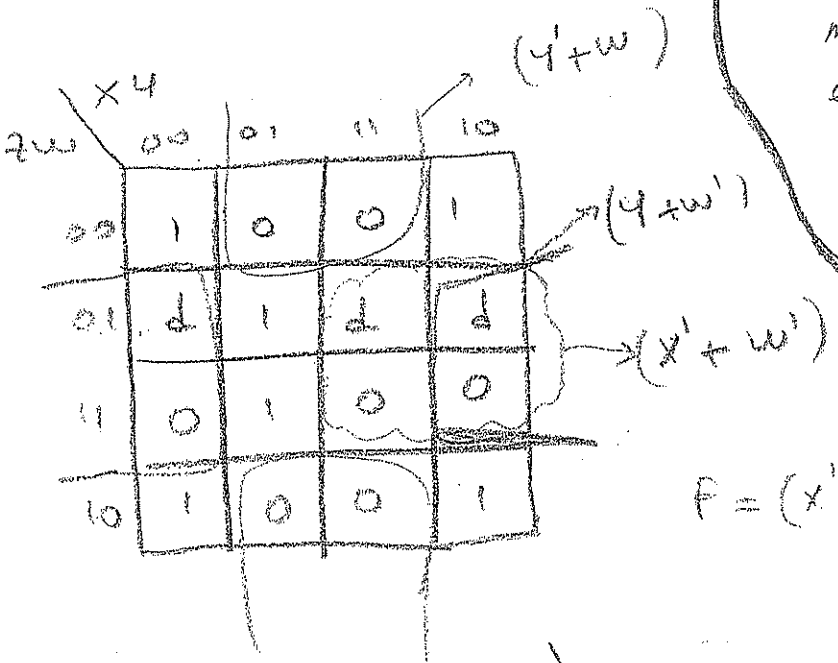
PoS (two ways)

- Essential prime implicants must be included in every minimal sum.

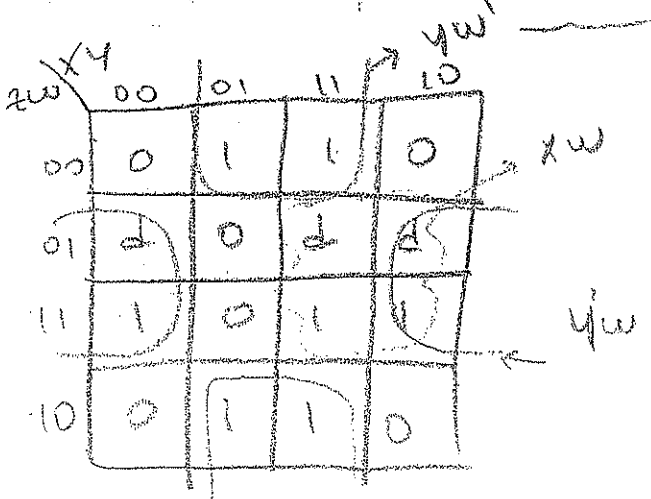
$\Rightarrow$ Start with including essential prime implicants!

Col-wise distinguished 1 cell

PoS



$F = (x'+w')(y'+w)(y+w')$



$F' = xw + yw' + y'w$

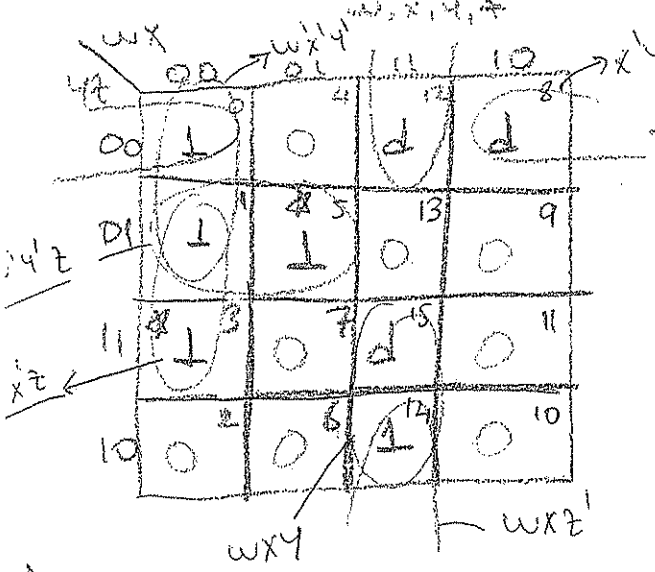
$F = (x'+w')(y'+w)(y+w')$

write F' and find one first

Q4

Find minimal SOP expressions

$f = \sum_{w,x,y,z}(0,1,3,5,14) + d(8,12,15)$



2 essential

$f_1 = w'y'z + w'x'z + w'x'y' + wxy$

$f_2 = w'y'z + w'x'z + wx'y' + wxz'$

$f_3 = w'y'z + w'xz + x'y'z' + wxy$

$f_4 = w'y'z + w'x'z + x'y'z' + wxz'$

* Distinguished ones! Prime implicants including them are essential prime implicants

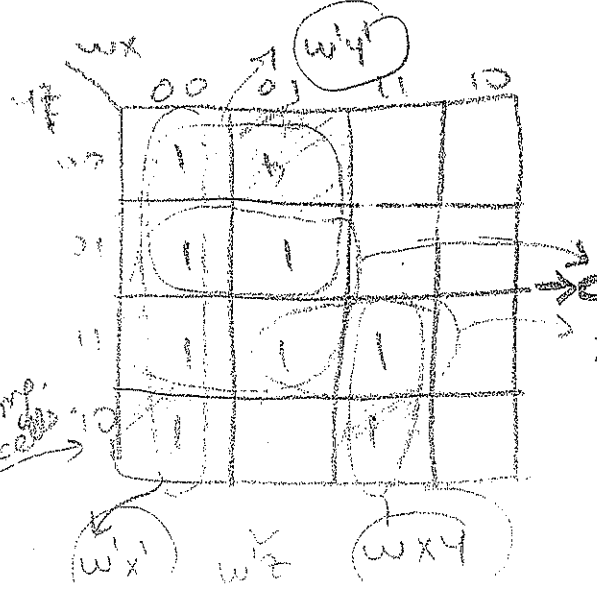
You should take them in any case!

→ After taking essential prime implicants, if there still remains 1's that are not covered, take also the prime implicants (the largest ones) that cover these 1's.

Q5

Find minimal SOP of,

$F = \sum_{w,x,y,z}(0,1,2,3,4,5,7,14,15)$

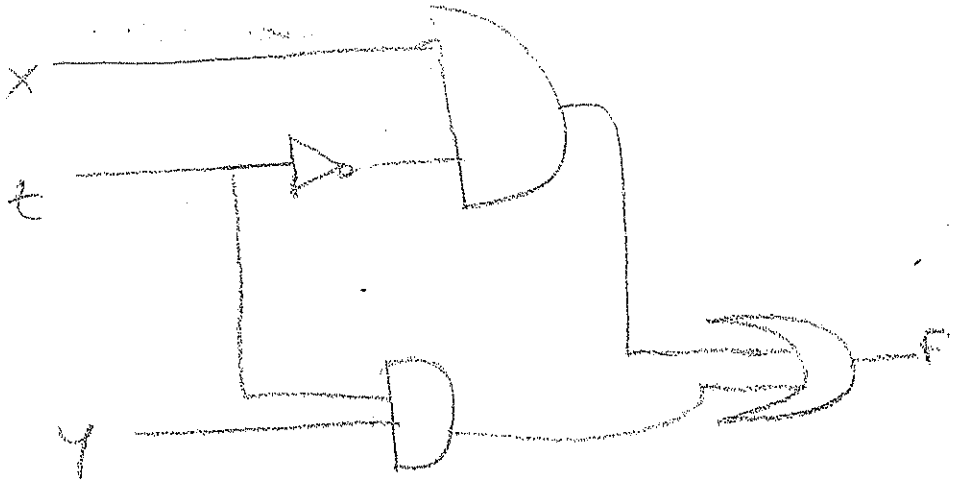


→ Find prime implicants first.
→ Spot the distinguished 1 cells
→ Choose the essential prime implicants
→ Choose the largest!

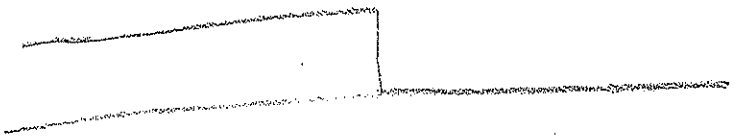
Minimal!

⇒ $F = w'y' + w'x' + wxy' + wxz$ OR $+ xyz$

Q 6

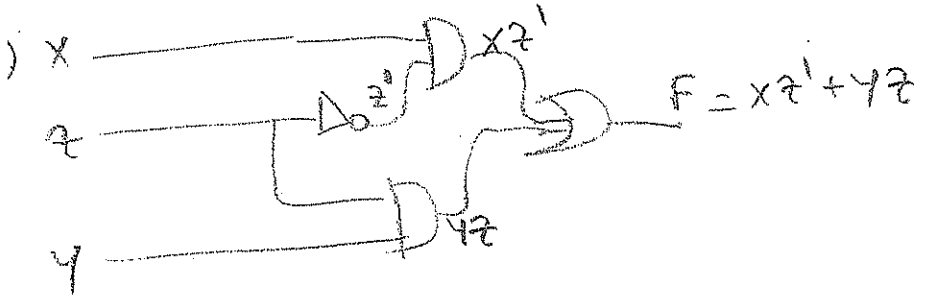


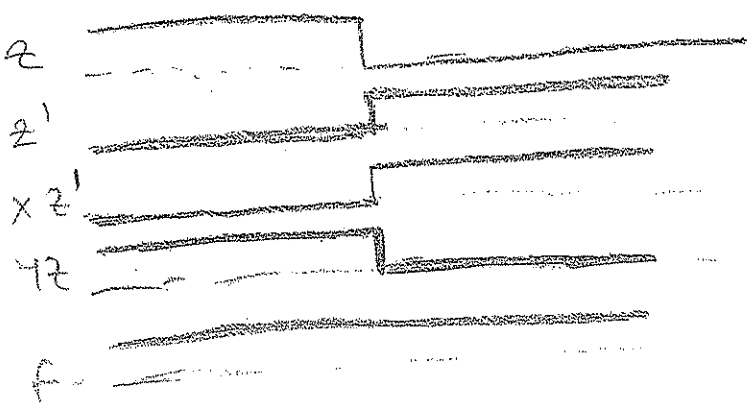
z:

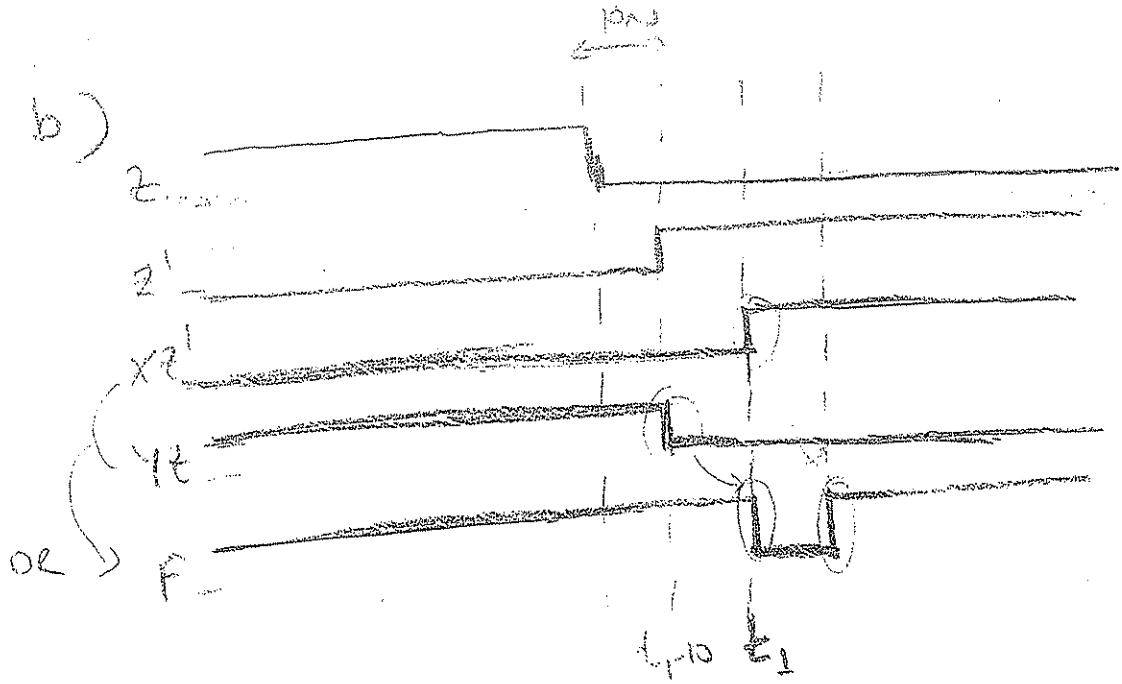


a) Draw the time waveform of F if the gates do not have any delays

b) Draw the time waveform of F if each gate has 10 ns delay. Assume x = y = 1 throughout. for the given z







Observation

$F = xz' + yz = 1z' + 1z = z' + z = 1$

F must be 1 always. Looking at expression of F

However such expressions are steady state expressions.

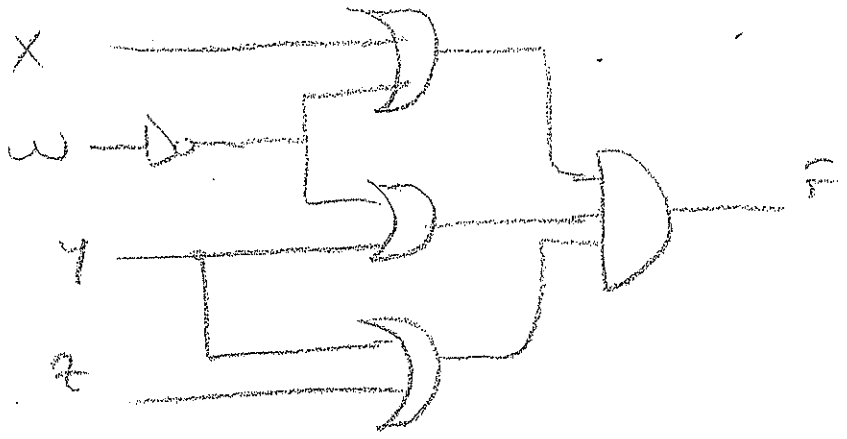
Expression $\xrightarrow{\text{implies}}$ steady state $\simeq$ no delay of gates

(If inputs are fixed for a long time)

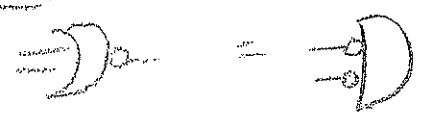
Q7) Draw the schematics of

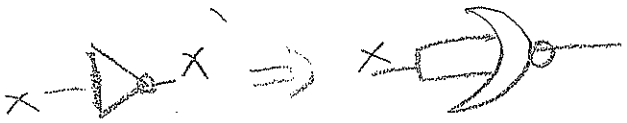
$F = (w'+x)(w'+y)(y+z)$ using

NOR gates only



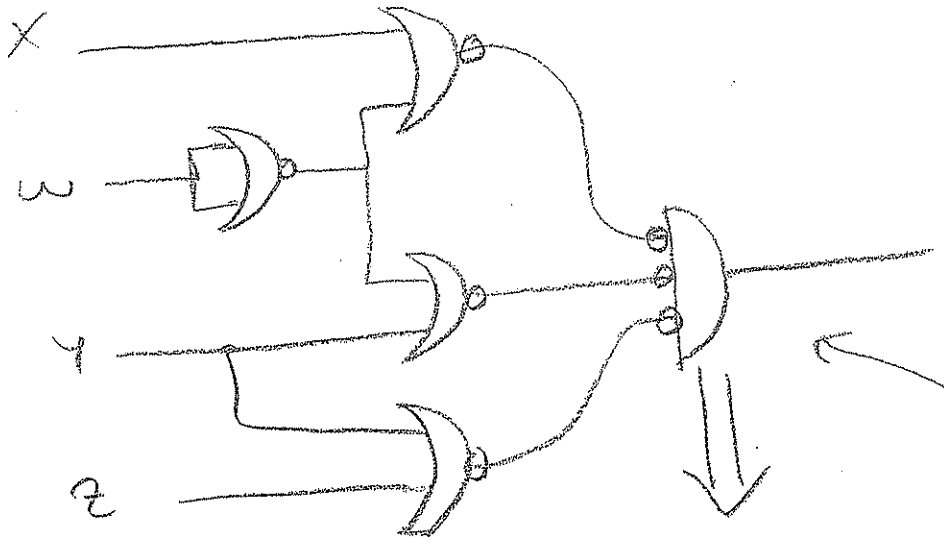
NOR





$(x+x)' = x'$

x



$x'y'z' = (x+y+z)'$