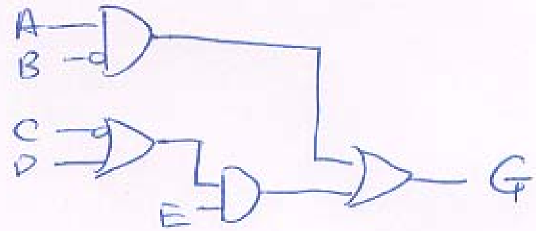
SOLUTIONS (eddieng@eecs)

1, $F = AB \oplus C$

2, $G = A\overline{B} + (\overline{C} + D)(E)$



3, $F = A\overline{B} + ABC$

Before start drawing this one, we can simplify F by:

$F = A(\overline{B} + \cancel{B}C)$

redundant $\Rightarrow \overline{B} + BC \equiv \overline{B} + C$

BC	$\overline{B}$	BC	$\overline{B}$+BC	$\overline{B}$+C
00	1	0	1	1
01	1	0	1	1
10	0	0	0	0
11	0	1	1	1

SAME

$F = A(\overline{B} + C)$

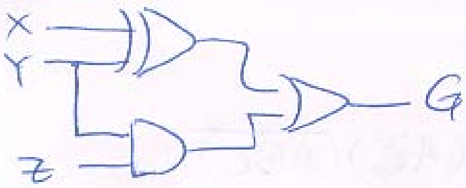
4, $G = \overline{X}Y\overline{Z} + YZ + \overline{Y}X = Y(\overline{X}\cancel{\overline{Z}} + Z) + \overline{Y}X$

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

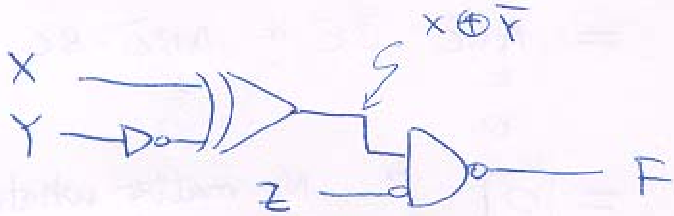
$= Y\overline{X} + YZ + \overline{Y}X$ (Combine 1st & 3rd terms)

$= X \oplus Y + YZ$

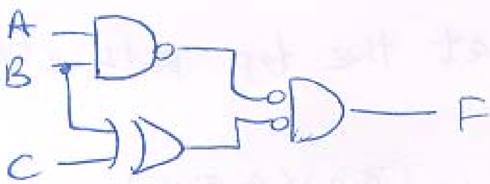
4 (cont)



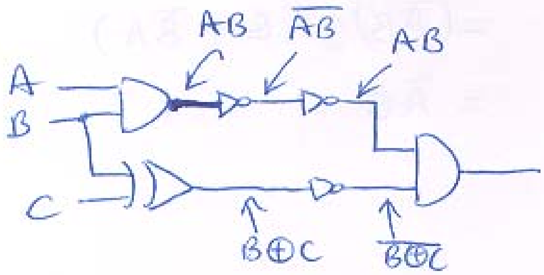
5, $F = \overline{(X \oplus \overline{Y})(\overline{Z})}$



6,



If you have problem with the circle notations, replace them with inverters:



$$F = (AB)(\overline{B \oplus C})$$

$$= (AB)(BC + \overline{B}\,\overline{C})$$

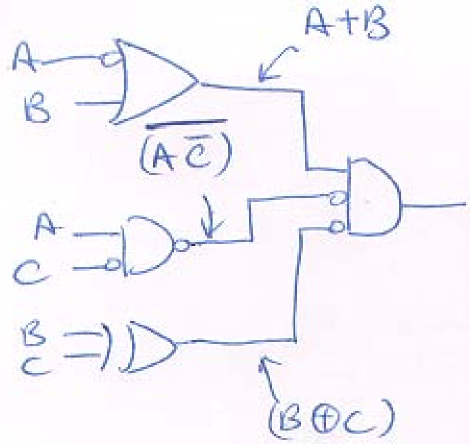
$$= AB \cdot BC + \cancelto{0}{AB \cdot \overline{B}\,\overline{C}}$$

$X \cdot \overline{X} \equiv 0$ guarantee!

$X \cdot X \equiv X$

$$= \boxed{ABC}$$

7,



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

$$= (\cancel{\bar{A}\cdot A\bar{C}}^{\to 0} + B\cdot A\bar{C})(\bar{B}\bar{C}+BC)$$

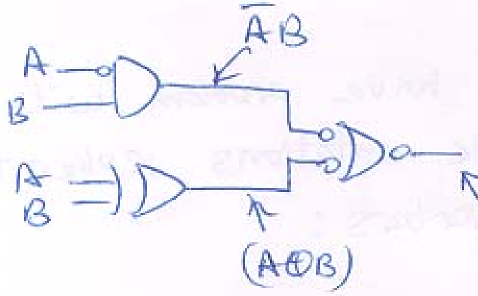
$$= (AB\bar{C})(\bar{B}\bar{C}+BC)$$

$$= \underbrace{\cancel{AB\bar{C}\cdot\bar{B}\bar{C}}}_{0} + \underbrace{\cancel{AB\bar{C}\cdot BC}}_{0}$$

$$= \boxed{0}\ !$$

No matter what the inputs are, $G=0$ always

8,

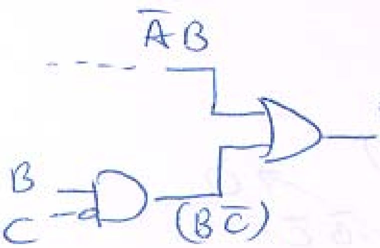


(let's look at the top path 1st.)

$$\overline{(\overline{\bar{A}B} + \overline{A\oplus B})} = (\bar{A}B)(A\oplus B)$$

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

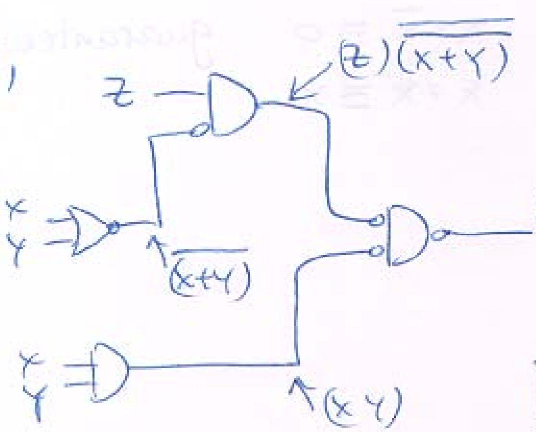
$$= \bar{A}B$$



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

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

9,

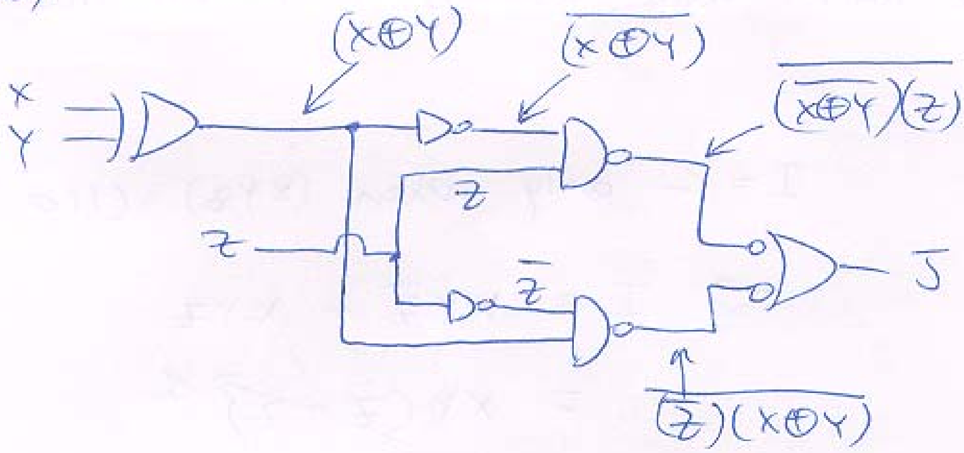


$$K = \overline{\left(\overline{Z\overline{\overline{(X+Y)}}}\ \overline{(XY)}\right)}$$

$$= Z(X+Y) + XY$$

$$\boxed{K = ZX + ZY + XY}$$

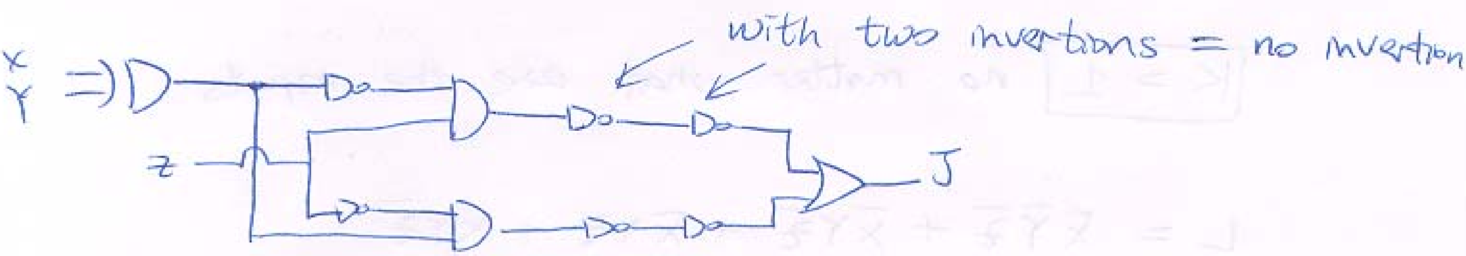
9 (cont)



$$J = \overline{(X \oplus Y)} Z + \bar{Z}(X \oplus Y)$$

$$\boxed{J = X \oplus Y \oplus Z}$$

Again the circles can be replaced by inverters ...



if X is replaced by A
Y " " by B
Z " " by Ci
K " " by Cout
J " " by SUM

$\Longrightarrow$ This is a 1-bit FULL ADDER !!

10, From the turth table, always focus on the 1's

	X Y Z	I
	⋮	0
	⋮	⋮
$XY\bar{Z} \rightarrow$	1 1 0	1
$XYZ \rightarrow$	1 1 1	1

$I = 1$ only when $(XYZ) = (110\ \&\ 111)$

$$\Rightarrow I = XY\bar{Z} + XYZ$$

$$= XY\cancel{(\bar{Z} + Z)} \rightarrow 1$$

$$I = \boxed{XY}$$

$J = 1$ when there is <u>odd</u> number of 1's.

$$\boxed{J = X \oplus Y \oplus Z}$$

$\boxed{K = 1}$ no matter what are the inputs.

$$L = \bar{X}\bar{Y}\bar{Z} + \bar{X}Y\bar{Z} + \bar{X}YZ + XY\bar{Z}$$

$$= \bar{X}\bar{Z}\cancel{(\bar{Y} + Y)}^{\rightarrow 1} + \bar{X}YZ + XY\bar{Z}$$

$$= \bar{X}(\bar{Z} + Y\cancel{Z}) + XY\bar{Z}$$

$$= \bar{X}\bar{Z} + \bar{X}Y + XY\bar{Z}$$

$$= \bar{X}\bar{Z} + Y(\bar{X} + \cancel{X}\bar{Z})$$

$$\boxed{L = \bar{X}\bar{Z} + \bar{X}Y + Y\bar{Z}}$$

$$M = X\bar{Y}\bar{Z} + XYZ$$

$$= X(\bar{Y}\bar{Z} + YZ)$$

$$\boxed{M = X(\overline{Y \oplus Z})}$$

$N = 1$ in all cases except when $X = Y = Z = 0$

in this case it's easier to obtain $\overline{N}$

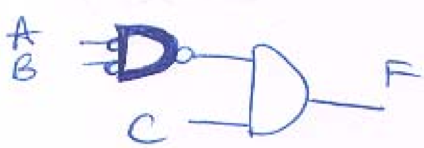
$\overline{N} = \overline{X}\,\overline{Y}\,\overline{Z}$ or $\boxed{N = \overline{(\overline{X}\,\overline{Y}\,\overline{Z})}}$

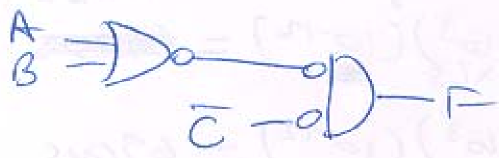
11a, $F = (A+B)(C)$

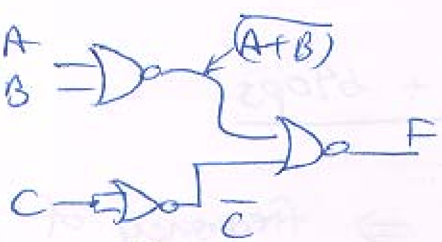
b, De Morgan's theorem states that:

$X + Y = \overline{(\overline{X}\,\overline{Y})}$

$F = (A+B)(C) = \overline{(\overline{A}\,\overline{B})}(C)$ it would be easier to look at the circuit.





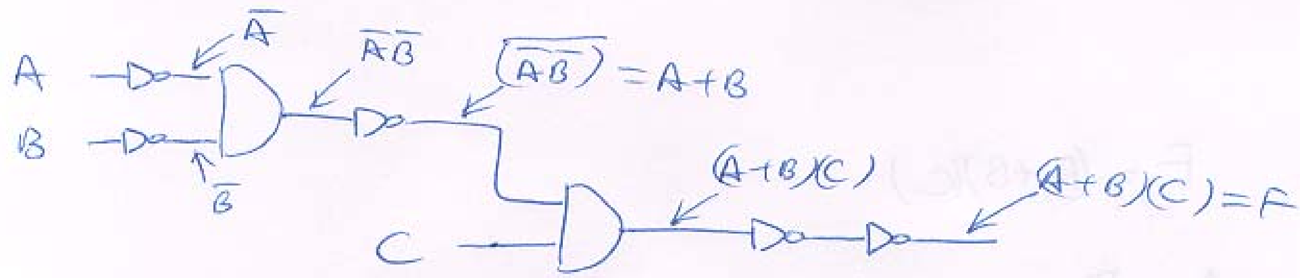


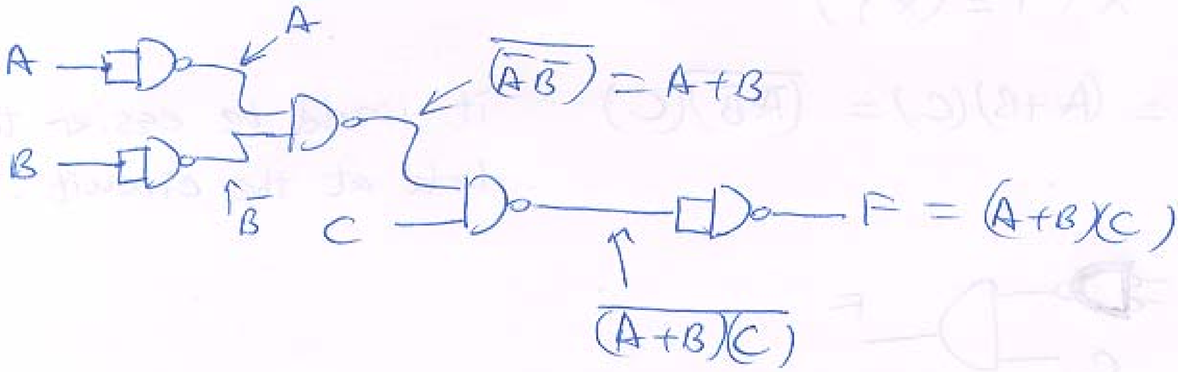
this behaves like an inverter

	NOR
00	1
01	0
10	0
11	0

inputs are the same

11c





12, t_{pLH} (propagation delay from low to high)

$= (0.69)(R_p)(C_L) = (0.69)(10^3 \times 1.5)(10^{-12}) = \cancel{690ps}$ $1.035ns$

$t_{pHL} = (0.69)(R_N)(C_L) = (0.69)(10^3)(10^{-12}) = 690ps$

$t_p = \dfrac{t_{pLH} + t_{pHL}}{2} = \dfrac{1.035ns + 690ps}{2}$

$= \boxed{863ps}$ $\Rightarrow$ frequency of 1.1GHz