1. A) Simplify the expression F(q, r, s ,t) = (r!s+!qt)(q!r+s!t)

```
(r!s+!qt)(q!r+s!t)
(q!r+s!t)r!s+(q!r+s!t)!qt
 r!sq!r+r!ss!t+(q!r+s!t)!qt
 r!ss!t+(q!r+s!t)!qt
 (q!r+s!t)!qt
 !qtq!r+!qts!t
 !qts!t
 0
```

B) Simplify the expression F(q,r) = !(q+r)!(!q+!r)

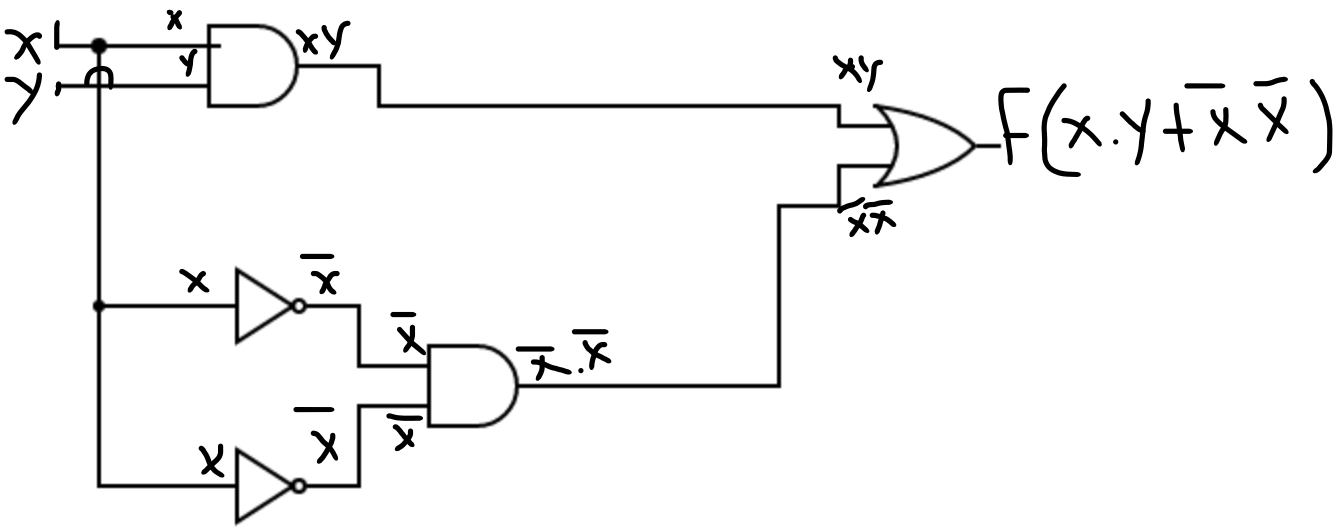
```
!(q+r)!(!q+!r)
 (!q!r)!(!q+!r)      DeMorgan's law
 (!q!r)(qr)          DeMorgan's law and double complement law
      0              Inverse law  x!x=0
```

C) Simplify the expression F(q,r,s)= !q(!rs+rs)+qrs

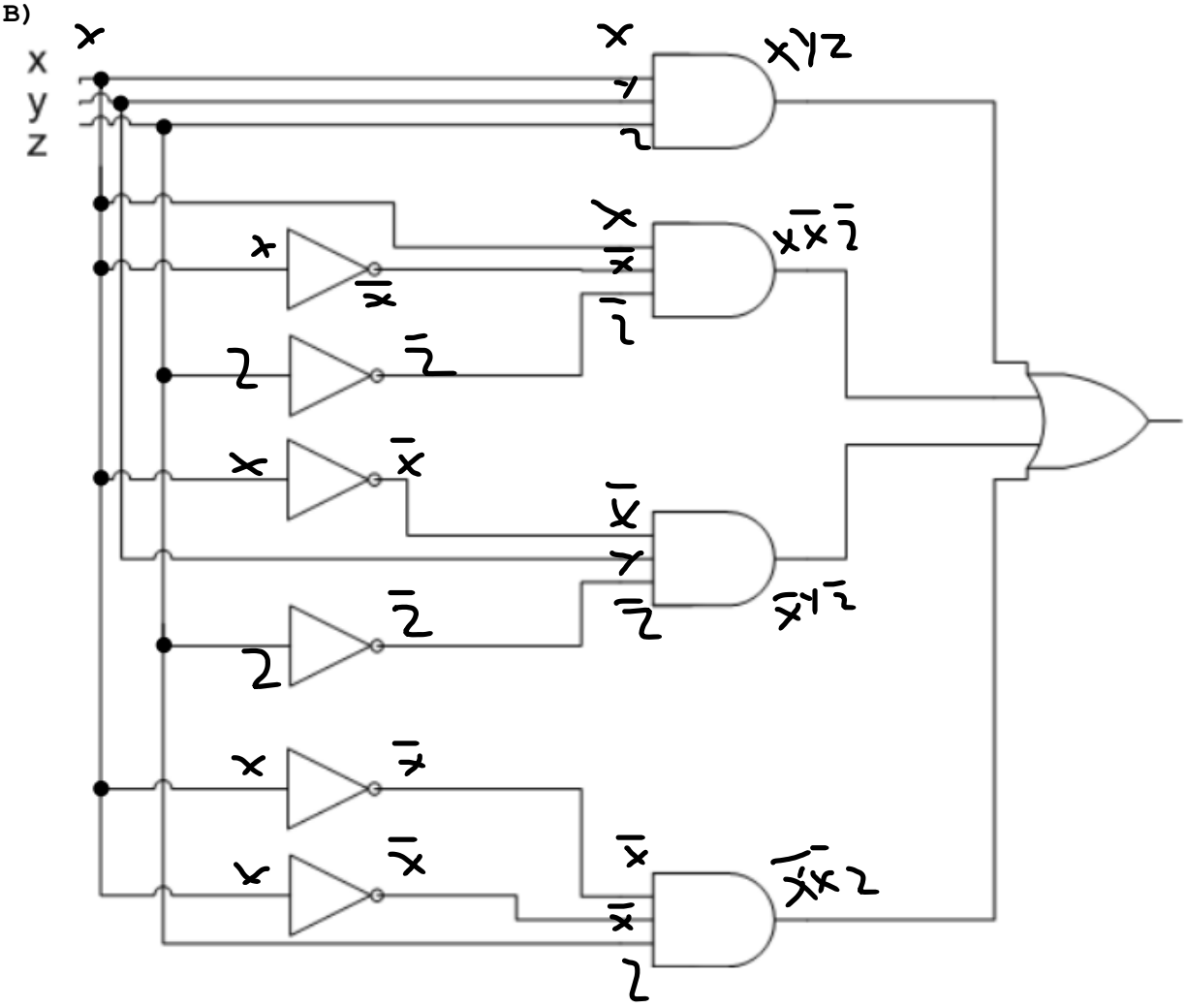
```
!q(!rs+rs)+qrs
!qs(!r+r)+qrs
!qs(1)+qrs
!qs+qrs
s(qr+!q)
sr+s!q
```

2. A) (We could also say that !x!x= !x but I chose to keep it as !x!x)

X	Y	!X	XY	!X!X	F=(XY+!X!X)
0	0	1	0	1	1
0	1	1	0	1	1
1	0	0	0	0	0
1	1	0	1	0	1



B)

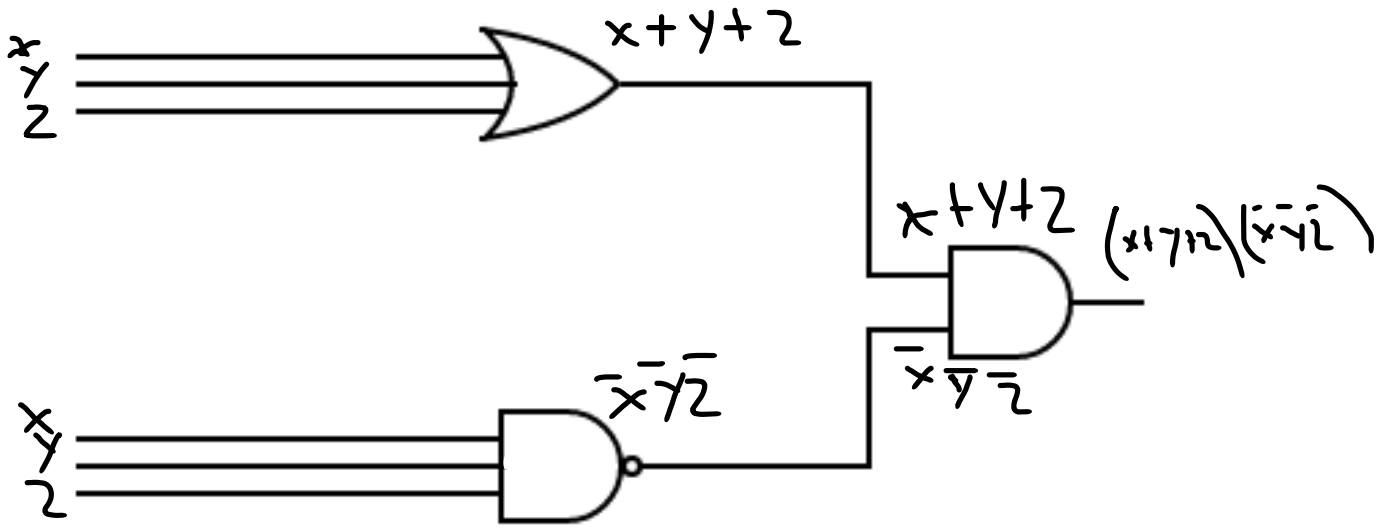


F= XYZ + X!X!Z + !XY!Z + !X!XZ

XYZ	!X	!Z	X!X!Z	!XY!Z	!X!XZ
000	1	1	011	101	110
001	1	0	010	100	111
010	1	1	011	111	110
011	1	0	010	110	111
100	1	1	101	001	000
101	0	0	100	000	001
110	0	1	101	011	000
111	0	0	100	010	001

X	Y	Z	!X	!Z	XYZ	X!X!Z	!ZY!Z	!X!XZ	F=(XYZ + X!X!Z+!XY!Z+!X!XZ)
0	0	0	1	1	0	0	0	1	1
0	0	1	1	0	0	0	0	0	0
0	1	0	1	1	0	0	1	1	1
0	1	1	1	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0	0
1	0	1	0	0	0	0	0	0	0
1	1	0	0	1	0	0	0	0	0
1	1	1	0	0	1	0	0	0	1

3. Combinational Circuit for (x+y+z)(x′y′z′)



4. A)Describe F in sum of products form

F(x,y,z)= ∑ (m2, m3, m6, m7)

X	**Y**	**Z**	**F**
M(0)0	0	0	0
M(1)0	0	1	0
M(2)0	1	0	1
M(3)0	1	1	1
M(4)1	0	0	0
M(5)1	0	1	0
M(7)1	1	1	1

M2= !xy!z
M3= !xyz
M6= xy!z
M7= xyz

F= M2 + M3 + M6 + M7

F= !XY!Z + !XYZ + XY!Z + XYZ

B)Simplify the function

F= !xy!z + !xyz + xy!z + xyz

F= !xy(!z+z)+xy(!z+z)

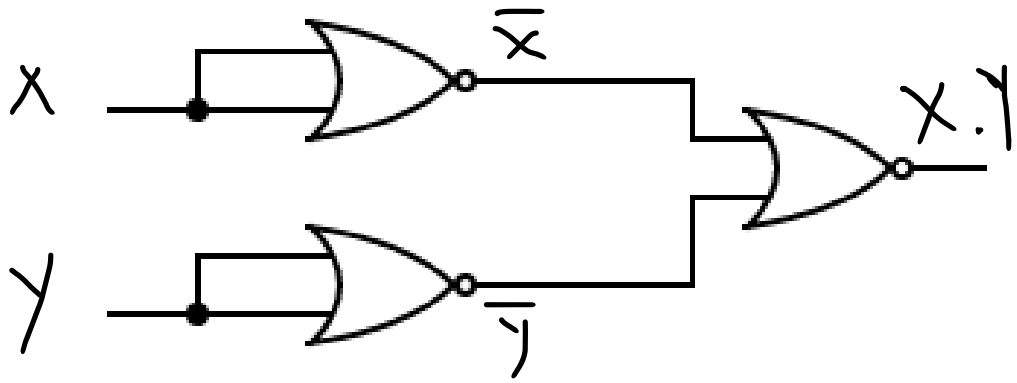
!z+z = 1

F= !xy+xy

F= y(!x+x)

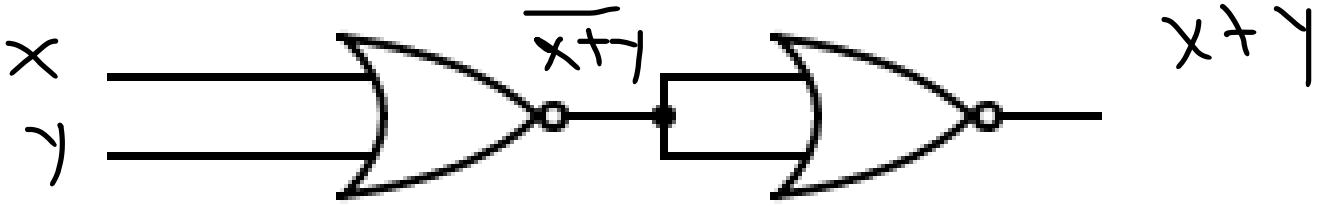
F= y

5. A) Drawing the circuit AND using only NOR



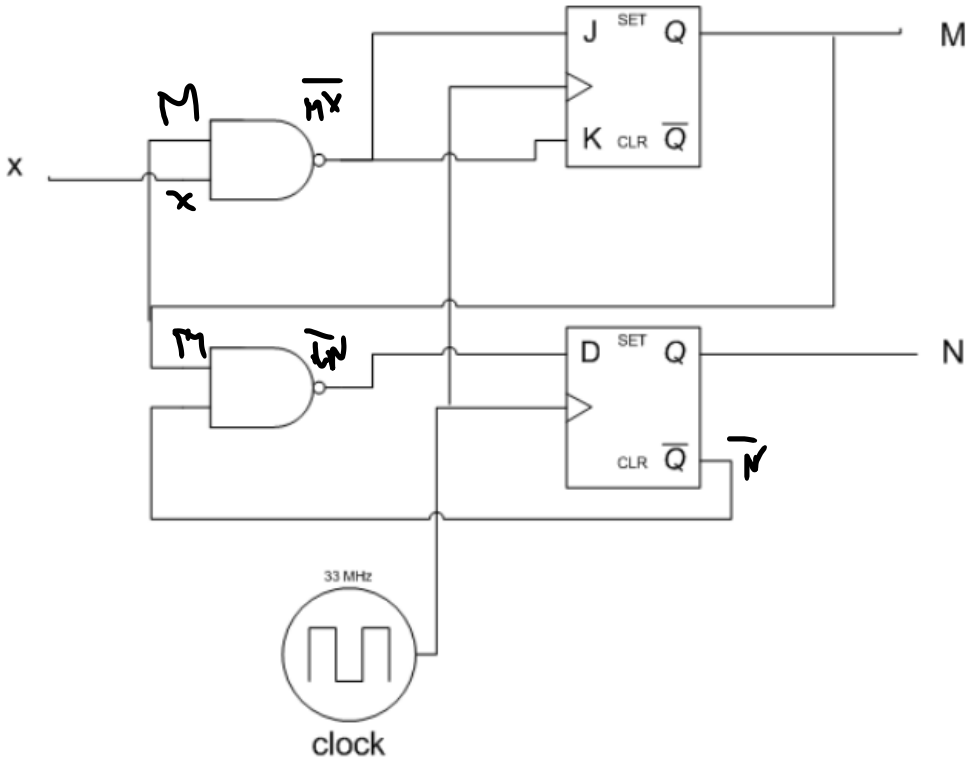
The reason why we ended up with X.Y is because X'+Y' = (X'+Y')' = X.Y using Demorgan's law.

B) Drawing the circuit OR using only NOR



The reason why we ended up with X+Y is because !(X+Y)= !X!Y= !(!X!Y)= X+Y

6.



J= !(XM)

K=!(XM)

D= !M+N

JK Truthtable:

CLK	**J**	**K**	**Qn+1**
0	X	X	Qn
1	0	0	Qn
1	0	1	0
1	1	0	1
1	1	1	!Qn

Current State | Input | J.K (States) | Next State

M	N	X	J= !(XM)	K= !(XM)	D= !M+N	M(t+1)	N(t+1)
0	0	0	1	1	1	1	1
0	0	1	1	1	1	1	1
0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	1
1	0	0	1	1	0	0	0
1	0	1	0	0	0	1	0
1	1	0	1	1	1	0	1
1	1	1	0	0	1	1	1