Problem 1 (20 points)

a) $(25)_{11} = (x)_y$

Find base y, such that the number of non-leading zeros in x is maximum.
Example:
The number of non- leading zeros in 10021 is 2.
The number of non-leading zeros in 204003 is 3.

if base is small, need more digits

b) $(A1965321)_{16} = (a)_8$
Find the value for a.

a) $(25)_{11} = (5+22)_{10} = (27)_{10}$

$(27)_{10} =$

$\frac{1}{27}\ \frac{0}{9}\ \frac{0}{3}\ \frac{0}{1} \rightarrow \boxed{3} = y$

$\frac{0}{64}\ \frac{1}{16}\ \frac{2}{4}\ \frac{3}{1}$

10

$\left(\frac{1}{16}\ \frac{1}{8}\ \frac{0}{4}\ \frac{1}{2}\ \frac{1}{1}\right)_2 \rightarrow 1$

24+4=28

b) $A1965321_{16} =$ 01010 0001 1001 0110 0101 0011 0010 0001

16 = 4 bits 0000 − 1111
8 = 3 bits 000 − 111

10

$\boxed{a = 24145451441}$

1+2+4+8 = 15

10

010 100 001 100 101 000 101 001 100 100 001
2 4 1 4 5 4 5 1 4 4 1

Problem 5 (20 points) NAND NOR

Find all the 2 input gates which form universal sets by itself (Universal set with only one gate). You can use constants 0 and 1.

a	b	NAND
0	0	1
0	1	1
1	0	1
1	1	0

NOT $a' = NAND(a, a)$

AND $ab = NAND(NAND(a,b), NAND(a,b))$

OR $a+b = (a'b')'$

✓

a	b	f	f(a',b')	f(a',b)
0	0	1	1	1
0	1	0	1	1
1	0	1	0	1
1	1	1	1	0

NOT: $a' = f(a,$

$f(a',b) \rightarrow$ NAND & {NAND} is universal so f is univ.

a	b	NOR
0	0	1
0	1	0
1	0	0
1	1	0

NOT: $a' = NOR(a, 0)$

OR: $a+b = (NOR(a,b))'$

AND: $ab = (a'+b')'$

✓

a	b	h	h(a,b')
0	0	0	1
0	1	1	0
1	0	0	0
1	1	0	0

$h(a,b') \leftrightarrow$ NOR {NOR} is univ so h is univ

OTHERS:

a	b	f	g	h	i			
				0	1	1	1	0
0	0	0	0	0	1	0	0	1
0	1	1	0	0	1	1	0	1
1	0	0	1	0	0	1	1	0
1	1	0	0	1	0	0	1	0

AND, XOR, are not

a	b	g	a+b	g(a',b)
0	0	1	0	0
0	1	1	1	1
1	0	0	1	1
1	1	1	1	1

✓

NOT: $g(a,a')$

OR: $g(a',b)$

{OR, NOT} is universal so g is universal

a	b	j	h(a',b)
0	0	0	1
0	1	0	0
1	0	1	0
1	1	0	0

3 0's

$j(a',b) \leftrightarrow$ NOR. {NOR} is univ

j is univ.

		k	k(a',b')
0	0	0	1
0	1	1	1
1	0	1	1
1	1	1	0

ok

$T_1 = (a+b'c)$
$T_2 = (a'+de'+f)$
$T_3 = a'b' = (a+b)'$
$T_4 = (T_1'T_2)'$

$a+b'c = b'c+a$

Problem 4 (20 points)

$(a+b)'$

$F(a,b,c,d,e,f) = ((\overset{T_1}{a+b'c})'(\overset{T_2}{a'+de'+f}))'+(a'b')$

a	b	E(a,b)
0	0	1
0	1	0
1	0	1
1	1	1

$a+b$	$E(a,b')$	ab	ab'	$a'b$	$(E(a,b))'$	$E(a',b')$
0	0	0	0	0	0	1
1	1	0	0	1	1	1
1	1	0	1	0	0	0
1	1	1	0	0	0	1

$de' = (E(d',e))'$

a) Use only the "E" gate defined above to implement Boolean function F. You can use constants 0 and 1.

f'

b) Implement the Boolean function F using only multiplexers.

a)

$a' = E(0,a)$

$b+a = E(a,b')$

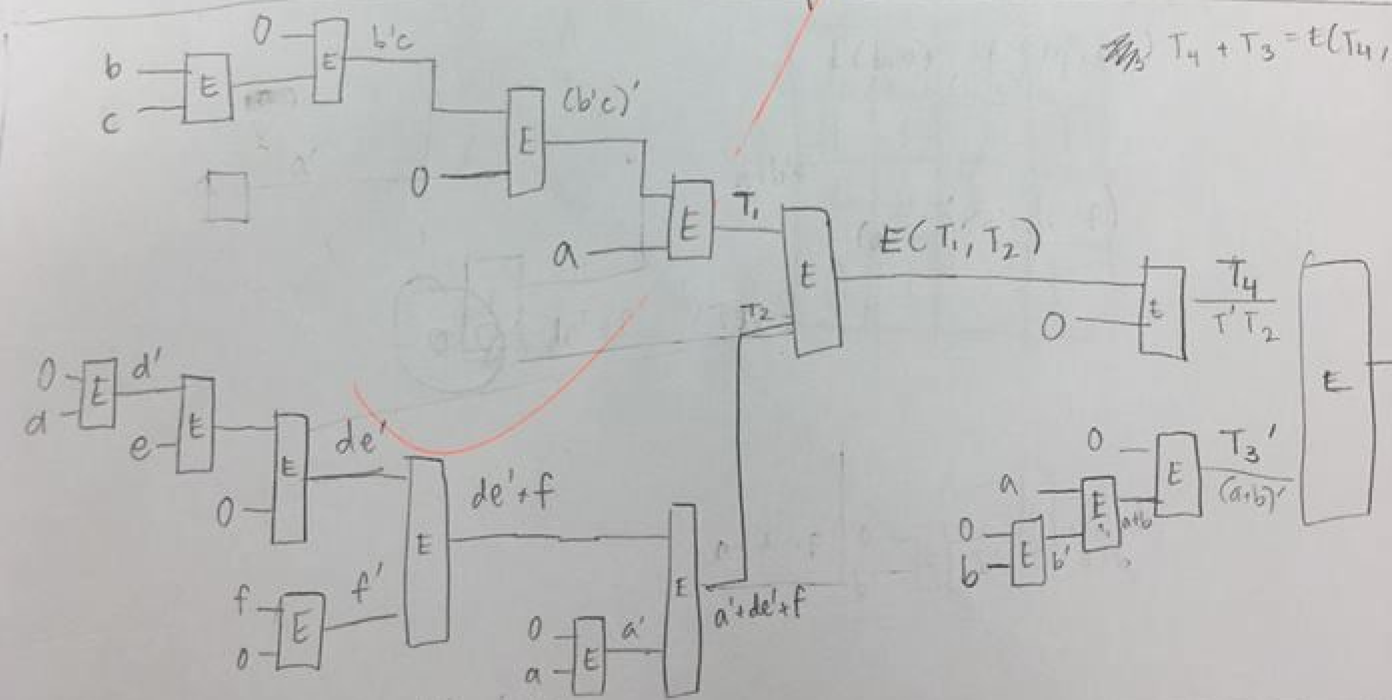
$a+b = E(a,b')$

$ab = (a'+b')' = E(0,(a'+b'))$
$= E(0, (E(0,a) + E(0,b)))$

$ab' = (E(a',b'))'$

$a'b = (E(a,b))'$

$T_4 + T_3 = E(T_4,$



$F = (T_1'T_2)' + T_3$

$T_1' = a+b'c = E(a, E(0, E(E(0,b), E(0,c)))$

$T_2 = a'+de'+f = E($

make sure it's correct by writing expression

Problem 3 (20 points)

For a K-map, M denotes the number of prime implicants of the K-map, and N denotes the number of essential prime implicants of the K-map. Draw a 4×4 K-map that has the largest value of P=M-N among all the 4×4 K-maps. For example, in the following 4×4 K-map, M=3, N=2, P=M-N=1

x_0

	0	0	0	0
	1	1	0	0
	1	1	1	0
x_3	0	0	1	0

x_2

x_1

X_3X_2
X_1X_0

1	0	1	1
1	1	1	0
0	1	0	0
1	1	1	0

X_3X_2
X_1X_0

1	0	1	1
1	1	1	0
0	1	0	0
1	1	1	0

M = 12
N = 0
P = 12

20

10

Problem 2 (20 points)

Create a state transition table that has 8 states, which satisfies the following conditions:

1) After minimization, it should have only 3 states.
2) Some states which are 2-equivalent are not 3- equivalent.

states which
can be diff. if you
apply any input of
length 2