BME208 LOGIC DESIGN AND CIRCUITS FINAL EXAM **11.Jan.2019**

Name: ANSWER KEY

ID:

1- Draw a 4-input and 4-output combinational circuit. It find the 2's complement of the input and give the output. (20 pts)

abcd --------------> ABCD

for Question #1

2- Draw a combinational circuit to find the number of days of the given month. For example, if the given number is 0110 (6=June), it gives 11110 (30). As an exception, if the given number is 0010 (2=February), then it gives 11100 (28). Show all the design steps separately. (25 pts)

3- Draw a sequential circuit using JK flip-flops to detect the input sequence of "011101" on the single input "i". It gives the output z=1, otherwise it gives z=0. (25 pts)

abcd --------------> ABCDE

for Question #

4- Draw a circuit using only NAND gates to implement the function F=A.B+B'.(C+D) (10 pts)

5- Find the conversion by showing all calculation steps. (20 pts)

a. $(21,34)_{10} = (?)_2$ in 8-bit for the integer and 8-bit for the fraction parts.

b. $(-113)_{10} = (?)_2$ in 8-bit binary number using 2's complement.

P.S. Duration is 150 minutes, calculator is forbidden.

For J-K Flip-Flops:

Q(t)	Q(t+1)	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

J	K	Q(t+1)
0	0	Q (t)
0	1	0
1	0	1
1	1	Q' (t)

1

abcd	ABCD
0000	0000
0001	1111
0010	1110
0011	1101
0100	1100
0101	1011
0110	1010
0111	1001
1000	1000
1001	0111
1010	0110
1011	0101
1100	0100
1101	0011
1110	0010
1111	0001

cd \ ab	00	01	11	10
00	0	1	0	1
01	1	1	0	0
11	1	1	0	0
10	1	1	0	0

$A = \bar{a}\cdot c + \bar{a}\cdot d + \bar{a}\cdot b + a\cdot\bar{b}\cdot\bar{c}\cdot\bar{d}$

cd \ ab	00	01	11	10
00	0	1	1	0
01	1	0	0	1
11	1	0	0	1
10	1	0	0	1

$B = \bar{b}\cdot c + \bar{b}\cdot d + b\cdot\bar{c}\cdot\bar{d}$

cd \ ab	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	0	0	0
10	1	1	1	1

$C = \bar{c}\cdot d + c\cdot\bar{d}$

cd \ ab	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	1	1	1	1
10	0	0	0	0

$D = d$

2

Month	a b c d	A B C D E	days
1	0 0 0 1	1 1 1 1 1	31
2	0 0 1 0	1 1 1 0 0	28
3	0 0 1 1	1 1 1 1 1	31
4	0 1 0 0	1 1 1 1 0	30
5	0 1 0 1	1 1 1 1 1	31
6	0 1 1 0	1 1 1 1 0	30
7	0 1 1 1	1 1 1 1 1	31
8	1 0 0 0	1 1 1 1 1	31
9	1 0 0 1	1 1 1 1 0	30
10	1 0 1 0	1 1 1 1 1	31
11	1 0 1 1	1 1 1 1 0	30
12	1 1 0 0	1 1 1 1 1	31
others	others	x x x x x	x

ab\cd	00	01	11	10
00	x	1	1	1
01	1	1	1	1
11	1	x	x	x
10	1	1	1	1

$A = 1$

ab\cd	00	01	11	10
00	x	1	1	1
01	1	1	1	1
11	1	x	x	x
10	1	1	1	1

$B = 1$

ab\cd	00	01	11	10
00	x	1	1	1
01	1	1	1	1
11	1	x	x	x
10	1	1	1	1

$C = 1$

ab\cd	00	01	11	10
00	x	1	1	0
01	1	1	1	1
11	1	x	x	x
10	1	1	1	1

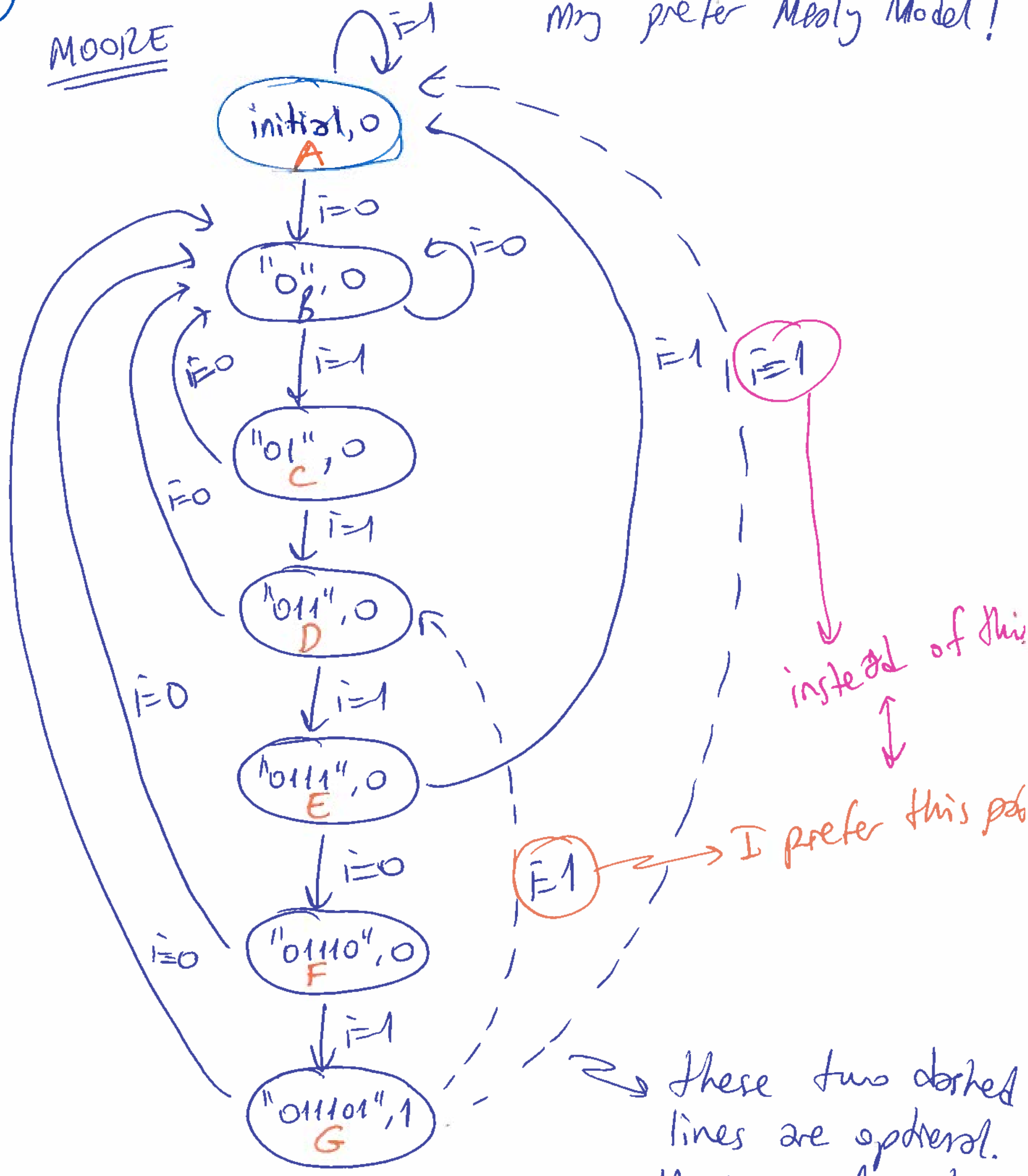
$D = a + b + d$

ab\cd	00	01	11	10
00	x	1	1	0
01	0	1	1	0
11	1	x	x	x
10	1	0	0	1

$E = \bar{a} \cdot d + a \cdot \bar{d}$

3

I choose Moore model, you may prefer Mealy Model!



these two dashed lines are optional. you are free to choose one of them.

After drawing this, you should give letters to all states like A, B, C, ... to simplify state transition table!

3 / cont'd

Present State	Next States		Output
	i= 0	i= 1	z
A	B	A	0
B	B	C	0
C	B	D	0
D	B	E	0
E	F	A	0
F	B	G	0
G	B	D	1

Let's assign binary numbers to states. We have 7 states, so we have to use 3 flip-flops:

Present State	Next States		Output
	i= 0	i= 1	z
0 0 0	0 0 1	0 0 0	0
0 0 1	0 0 1	0 1 0	0
0 1 0	0 0 1	0 1 1	0
0 1 1	0 0 1	1 0 0	0
1 0 0	1 1 0	0 0 0	0
1 0 1	0 0 1	1 1 0	0
1 1 0	0 0 1	0 1 1	1
1 1 1	x x x	x x x	x

Now, we can determine the inputs of the flip-flops using JK-FF Excitation Table given:

Present State			Next States												Output
			i= 0						i= 1						z
s0	s1	s2	J0	K0	J1	K1	J2	K2	J0	K0	J1	K1	J2	K2	
0	0	0	0	x	0	x	1	x	0	x	0	x	0	x	0
0	0	1	0	x	0	x	x	0	0	x	1	x	x	1	0
0	1	0	0	x	x	1	1	x	0	x	x	0	1	x	0
0	1	1	0	x	x	1	x	0	1	x	x	1	x	1	0
1	0	0	x	0	1	x	0	x	x	1	0	x	0	x	0
1	0	1	x	1	0	x	x	0	x	0	1	x	x	1	0
1	1	0	x	1	x	1	1	x	x	1	x	0	1	x	1
1	1	1	x	x	x	x	x	x	x	x	x	x	x	x	x

3/ cont'd

S_0 \ S_1S_2	00	01	11	10
0				1
1				X

$z = S_1 \cdot \overline{S_2}$

iS_0 \ S_1S_2	00	01	11	10
00				
01	X	X	X	X
11	X	X	X	X
10			1	

$J_0 = i \cdot S_1 \cdot S_2$

iS_0 \ S_1S_2	00	01	11	10
00	X	X	X	X
01		1	X	1
11	1		X	1
10	X	X	X	X

$K_0 = i \cdot \overline{S_2} + \overline{i} \cdot S_2 + S_1$

iS_0 \ S_1S_2	00	01	11	10
00			X	X
01	1		X	X
11		1	X	X
10		1	X	X

$J_1 = i \cdot S_2 + \overline{i} \cdot S_0 \cdot \overline{S_2}$

iS_0 \ S_1S_2	00	01	11	10
00	X	X	1	1
01	X	X	X	1
11	X	X	X	
10	X	X	1	

$K_1 = \overline{i} + S_2$

iS_0 \ S_1S_2	00	01	11	10
00	1	X	X	1
01		X	X	1
11		X	X	1
10		X	X	1

$J_2 = \overline{i} \cdot \overline{S_0} + S_1$

iS_0 \ S_1S_2	00	01	11	10
00	X			X
01	X		X	X
11	X	1	X	X
10	X	1	1	X

$K_2 = i$

4

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

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

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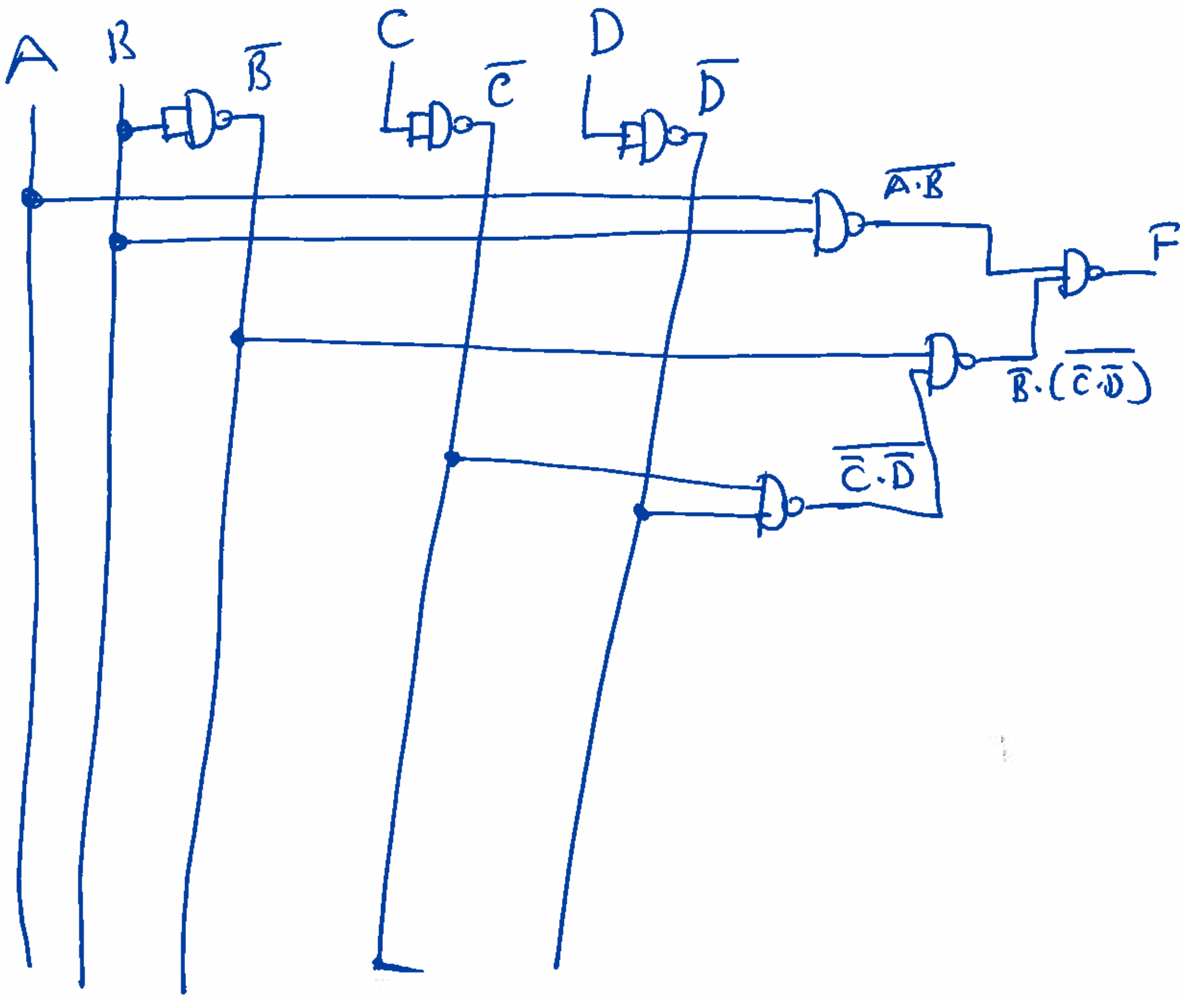
$$F = \overline{\overline{A \cdot B} \cdot \overline{\overline{B} \cdot (\overline{\overline{C} \cdot \overline{D}})}}$$

→ Please, only use double inverting! Never simplify using Boolean Algebra unless it is required!!!

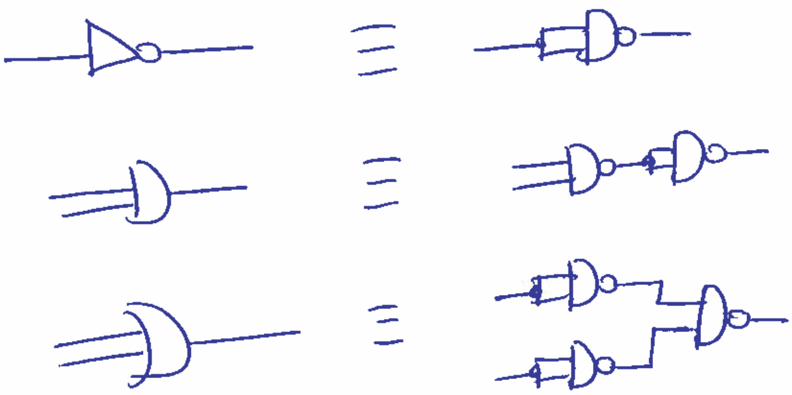


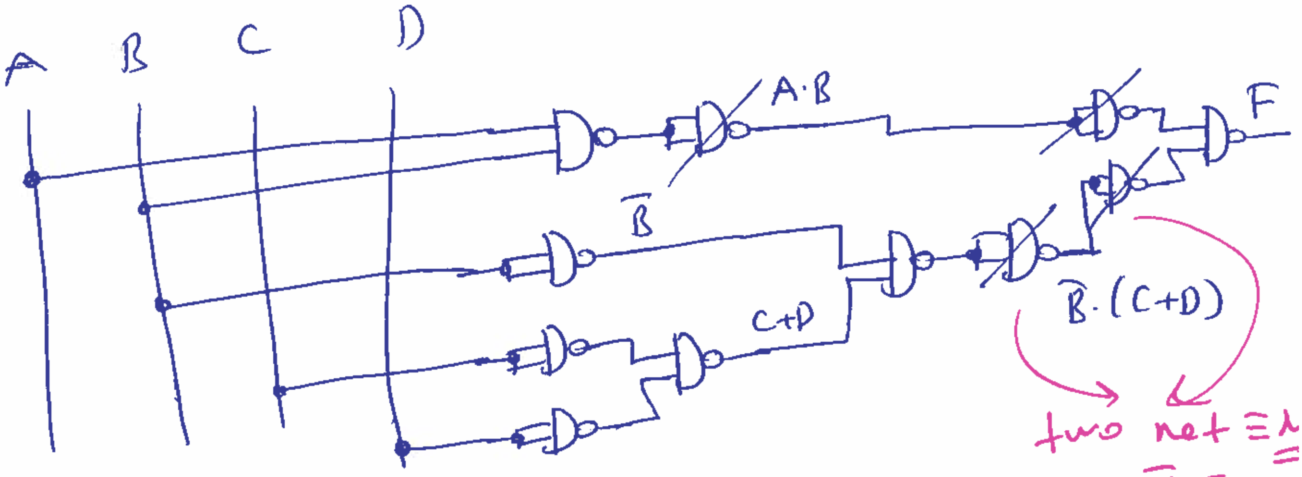
4

alternative

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

Please, never simplify thi first unles it is requi

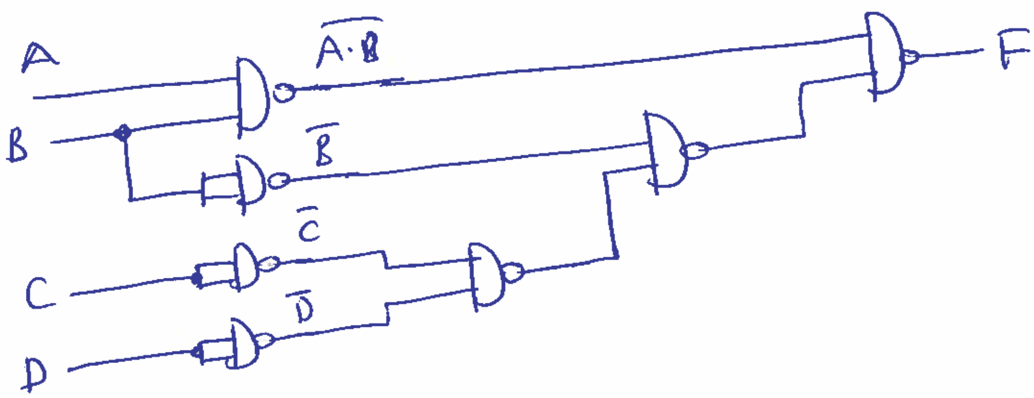




two not ≡

$\bar{\bar{A}} \equiv A$

So, resulting circuit is



$(21,34)_{10} = (\,?\,)_2$ in 8 bits. SHOW ALL STEPS!

5) a) for integer part:

21	1
10	0
5	1
2	0
1	

All zeroes to make it an 8-bit number!

0 0 0 1 0 1 0 1

inverted order

for fraction part:

$0,34 \times 2 = 0,68$

$0,68 \times 2 = 1,36$

$0,36 \times 2 = 0,72$

$0,72 \times 2 = 1,44$

$0,44 \times 2 = 0,88$

$0,88 \times 2 = 1,76$

$0,76 \times 2 = 1,52$

$0,52 \times 2 = 1,04$

normal order.

by combining these two parts:

$(21,34)_{10} = (00010101.01010111)_2$

5 b $(-113)_{10} = (?)_2$ SHOW ALL STEPS

Since it is a signed negative number, we will find the conversion as if it is a positive number first, and then we will apply 2's complement.

	↓÷2 remainders
113	
56	1
28	0
14	0
7	0
3	1
1	1
0	1

$(01110001)_2$

add this zero to make it an 8-bit number!

since it is a negative number:

(*) 01110001 ⟶ 10001110 (inversion)

+1 (plus 1)

(*) $(10001111)_2$ 2's compl

So,

$(-113)_{10} = (10001111)_2$