CSI 2111 Midterm Test

Tuesday, October 26, 2004, 14h30-16h00

Instructor: Amiya Nayak

Instructions: Please read carefully!

1. **Complete all sections of the identification area in ink.**
2. This is a closed-book test. **No books, papers, calculators or other electronic devices are permitted.**
3. There are eight questions on this test. Answer all eight questions on the question sheet in the area provided. **Questions answered in pencil will not be re-graded even if there is a marking error.**
4. The points allocated with each question are indicated. The questions do not have all the same weight, so plan your time accordingly. This examination will be scored out of 20 marks, which represents 20% of your final grade.
5. Only the final answers will be corrected.
6. You can use the back of the pages or detach pages 5 to 7 for your calculations and drafts. These pages can be detached if you want.
7. Information on algebraic theorems, Karnaugh maps, and flip-flops is also provided in the appendix.
8. Peeking at your neighbours' work may be the cause for expulsion from the exam.

Identification:

Name: ______________________

Student #: ___________________

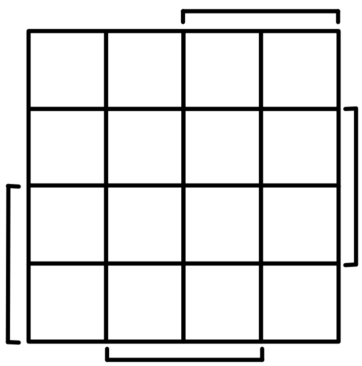
Good Luck!

For use of grader:

Question	Marks Available	Marks Received
1	2	
2	3	
3	2	
4	3	
5	3	
6	3	
7	2	
8	2	
Total	**20**	

Q1. Identify the decimal number represented in IEEE 754 form by:
$(0\ 01111111\ 11000000000000000000000)_{IEEE754} = (\ ?\ )_{10}$ (2)

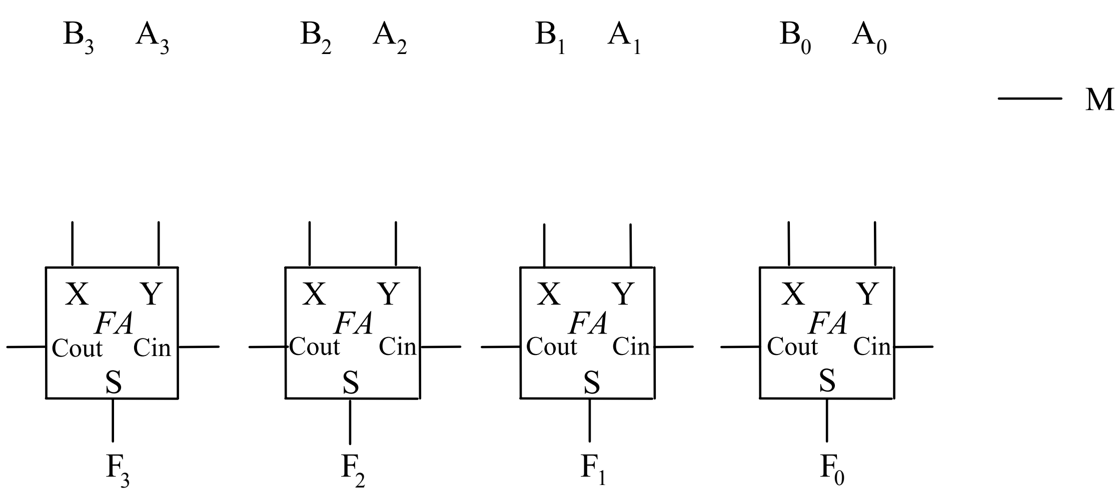
Q2. Give the **minimal POS** form of f(A, B, C, D) = (B ⊕ D)' + A'BC' (3)



f(A, B, C, D) = ____

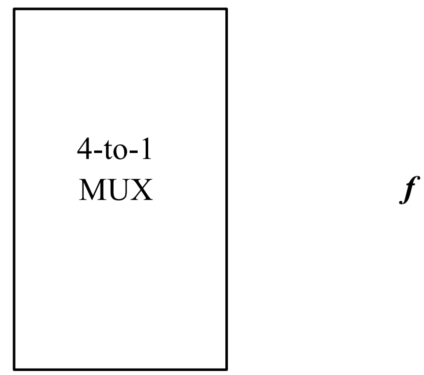
Q3. Complete the following circuit in order to implement a 4-bit adder-subtractor with a control input M : (2)

- When **M = 1**, the circuit computes **F = A + B** (i.e. addition in 2's CF).
- When **M = 0**, the circuit computes **F = A - B** (i.e. subtraction 2's CF).
- A, B, and F are signed integers in 2's complement form where $A = A_3A_2A_1A_0$, $B = B_3B_2B_1B_0$ and $F = F_3F_2F_1F_0$.



Q4. **Realize** the function $\boldsymbol{f}$ (A, B, C) = ΠM (0, 4, 7) using a 4-to-1 multiplexer, with A and C (in this order) as control inputs. <u>Identify</u> the MUX inputs/outputs. (3)

A	B	C	f
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



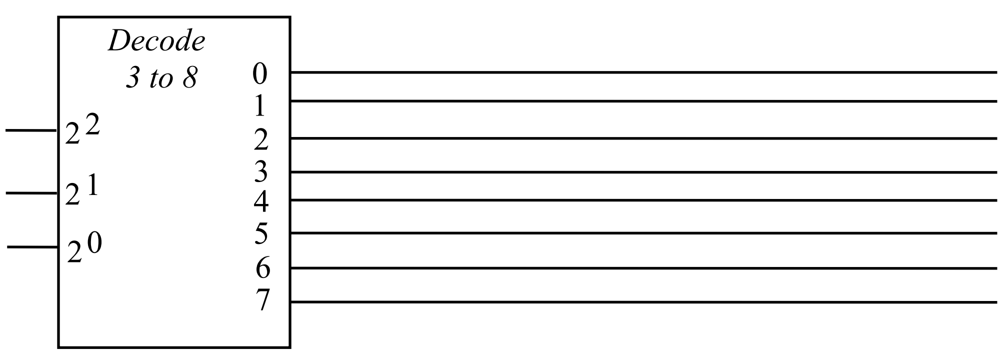
Q5. Consider the following functions:

F1 (A, B, C) = AB’ + A’C’ + BC

F2 (A, B, C) = (C + A’C’)’

F3 (A, B, C) = (*F1*’ . *F2*’)’

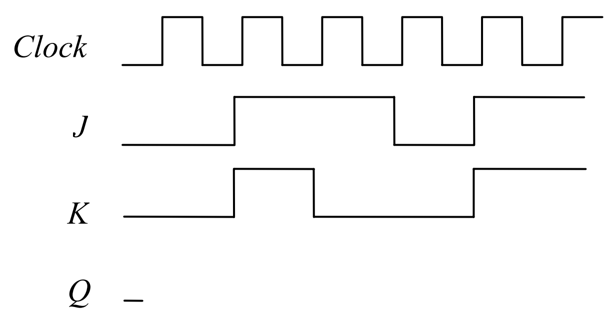
Implement these functions using a suitable ROM. Show connections using Xs. (3)



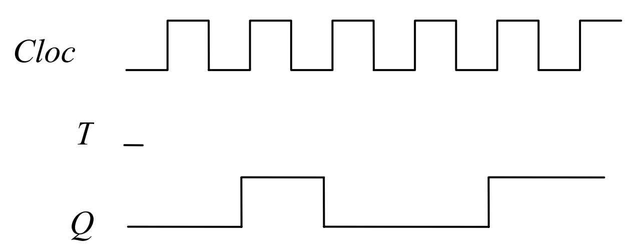
Q6. Give a VHDL expression for *f(A,B,C,D) = (ABC'+D)*. Use **`NAND`** operators only. (3)

Answer : **`f <=`**

Q7. Fill in the timing diagram below for a falling-edge triggered JK flip-flop. Assume Q begins at 0, and ignore propagation delays. (2)



Q8. Find the input for a rising-edge T flip-flop which will produce the output Q as shown. Assume T begins at 0, and ignore propagation delays. (2)



Algebraic laws and logic gates

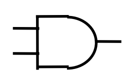
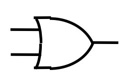
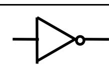
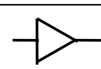
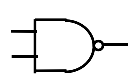
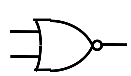
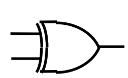
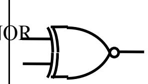
Postulates, or axioms :

P1) Logic variable:	$A = 0$ if $A \neq 1$ and $A = 1$ if $A \neq 0$
P2) NOT:	if $A = 0$, then $A' = 1$ and if $A = 1$, then $A' = 0$
P3) AND:	$0 \bullet 0 = 0 \bullet 1 = 1 \bullet 0 = 0$ and $1 \bullet 1 = 1$
P4) OR:	$0 + 0 = 0$ and $0 + 1 = 1 + 0 = 1 + 1 = 1$

Principal theorems:

Theorem	*AND Operator*	*OR Operator*
Identity element	$A \bullet 1 = A$	$A + 0 = A$
Commutative	$A \bullet B = B \bullet A$	$A + B = B + A$
Distributive	$A \bullet (B+C) = A \bullet B + A \bullet C$	$A + (B \bullet C) = (A+B) \bullet (A+C)$
Complementation	$A \bullet A' = 0$	$A + A' = 1$
Idempotence	$A \bullet A = A$	$A + A = A$
Universal bound	$A \bullet 0 = 0$	$A + 1 = 1$
Double negation	$A'' = A$	
Associative	$A \bullet (B \bullet C) = (A \bullet B) \bullet C$	$A + (B + C) = (A + B) + C$
Absorption	$A \bullet (A + B) = A$	$A + A \bullet B = A$
De Morgan	$(A \bullet B)' = A' + B'$	$(A + B)' = A' \bullet B'$

NOTE: $A' = \bar{A}$ (Complement), $AB = A \bullet B$ (Product).

Name	*Symbol*	*Algebraic Function*	*Truth Table*
AN		$F = A \bullet B$	A B F 0 0 0 0 1 0 1 0 0 1 1 1
OR		$F = A + B$	A B F 0 0 0 0 1 1 1 0 1 1 1 1
NO		F =	A F 0 1 1 0
(Buffer)		F =	A F 0 0 1 1
NAN		$F = A \uparrow B$, or $F = (A \bullet B)'$	A B F 0 0 1 0 1 1 1 0 1 1 1 0
NOR		$F = A \downarrow B$, or $F = (A + B)'$	A B F 0 0 1 0 1 0 1 0 0 1 1 0
Exclusive-OR (XOR)		$F = \oplus B$, or $F = (A \bullet B') + (A' \bullet B)$	A B F 0 0 0 0 1 1 1 0 1 1 1 0
Éxclusive-NOR (XNOR)		$F = \odot B$, or $F = (A' \bullet B') + (A \bullet B)$	A B F 0 0 1 0 1 0 1 0 0 1 1 1

Karnaugh Map

2 variables: *f*(A, B)

		B
	0	1
A	2	3

		B
	A'B'	A'B
A	AB'	AB

3 variables: *f*(A, B, C)

			B	B
	0	1	3	2
A	4	5	7	6
		C	C	

			B	B
	A'B'C'	A'B'C	A'BC	A'BC'
A	AB'C'	AB'C	ABC	ABC'
		C	C	

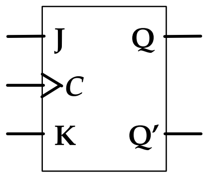
4 variables: *f*(A, B, C, D)

			C	C	
	0	1	3	2	
	4	5	7	6	B
A	12	13	15	14	B
A	8	9	11	10	
		D	D		

			C	C	
	A'B'C'D'	A'B'C'D	A'B'CD	A'B'CD'	
	A'BC'D'	A'BC'D	A'BCD	A'BCD'	B
A	ABC'D'	ABC'D	ABCD	ABCD'	B
A	AB'C'D'	AB'C'D	AB'CD	AB'CD'	
		D	D		

JK Flip-Flop

Circuit:



Characteristics Table:

J	K	$Q_{(t+1)}$	
0	0	$Q_{(t)}$	No change
0	1	0	Reset
1	0	1	Set
1	1	$Q'_{(t)}$	Complement

Characteristic Equation:

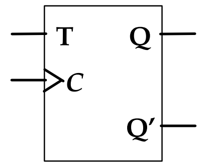
$Q_{(t+1)} = JQ'_{(t)} + K'Q_{(t)}$

Excitation Table:

$Q_{(t)}$	$Q_{(t+1)}$	J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

T Flip-Flop

Circuit:



Characteristic Table:

T	$Q_{(t+1)}$	
0	$Q_{(t)}$	No change
1	$Q'_{(t)}$	Complement

Characteristic Equation:

$Q_{(t+1)} = Q'_{(t)} .T + Q_{(t)} .T'$

Excitation Table:

$Q_{(t)}$	$Q_{(t+1)}$	T
0	0	0
0	1	1
1	0	1
1	1	0