Sample Exam 1

1-Oct-18

1 October 2018

_____ , _____

Last Name , First Name

Instructions:

- ***Show all work** on the **front** of the test papers. No work shown may mean 0 points given!* *If you need more room, make a clearly indicated note on the front of the page, "MORE ON BACK", and use the back. The back of the page will **not** be graded without an indication on the front.*
- ***Read** each question **carefully** and **follow the instructions**. Unless otherwise stated, **you must show your work and clearly illustrate your steps**.*
- *If you round a numerical answer, you must give at least **3 significant digits**.*
- *Put your name at the top of **each** test page and be sure your exam consists of the number of pages designated in the headers.*
- *The space provided does **NOT** necessarily represent the amount of writing necessary.*
- *You may **not** use any notes, homework, labs, or other books. Only **memoryless** calculator is allowed.*
- ***You may not use any notes, homework, labs, or other books.***

COMMENTS, FEEDBACK, or any special instructions for the professor:

Problem	Available	Points
1		
2		
3		
4		
5		
Total		

Important: *In completing this exam, I used a calculator with no communications capability, and no information of relevance to the course was stored in the calculator. I did not use any other electronic device or any other references. My work was solely my own.*

Your Calculator's Maker and Model#: _____, Signature: _____

You must sign this to receive credit for the exam.

Important Boolean Algebra Laws

Identity law
- A + 0 = A
- A·1 = A

Zero and One laws
- A + 1 = 1
- A·0 = 0

Associative laws
- A + (B + C) = (A + B) + C
- A· (B·C) = A· (B·C)

Distributive laws
- (B + C) = (A.B) + (B.C)
- A+(B·C) = (A+B) · (A+C)

DeMorgan's laws
- (A·B)'=A'+B'
- (A+B)'=A'·B'

Inverse laws
- A + A' = 1
- A·A' = 0

Commutative laws
- A + B = B + A
- A·B = B·A

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Remember to show <u>ALL</u> work here and in <u>EVERY</u> problem on this exam.

Q1. Do the following conversions (Note: The numbers in this problem are **unsigned** numbers. There is **no sign bit**. Your answer should also be unsigned numbers as well.).

a) $1110.11_2 = 14.75_{10}$

b) $14.625_{10} = 1110.101_2$

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Q2. Do the following conversions between decimal number and **8**-bit **signed** integer in the **2's complement** format. (**Note:** The binary numbers in this problem are **signed** 8-bit integers. When doing decimal-to-binary conversion, give your binary number answer in the same format. When doing binary-to-decimal conversion, indicate the sign of your decimal number answer.).

a) -9_{10} $=11110111_2$

b) $10000000_2=-128_{10}$

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Q3. Perform following binary calculation. Each number is an **8-bit signed integer** with 2's complement representation. **Give your answer in 8-bit 2's complement format and clearly state whether an overflow happens or not.** (**Note:** (1) your answer MUST BE 8-bit number. Deduction will be given for 9-bit or other representation. (2) If there is no overflow, you need to clearly state that an overflow does not happen)

a) $11101100_2+11000011_2$

Solution

10101111_2, no overflow

b) $01001111_2–10110001_2$

Solution

10011110_2, overflow

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Q4.

(a)

Use algebraic manipulation to convert the following Function F3 = (a + b)'c' + a(b' + c)' + a(b + d)'c to sum-of-products (SOP) form.

Solution:

$$F_3 = (a+b)'c' + a(b'+c)' + a(b+d)'c$$
$$= a' \cdot b' \cdot c' + a \cdot b \cdot c' + a b' \cdot d' \cdot c \quad \ldots\ \text{DeMorgan's Law}$$
$$F_3 = a'b'c' + abc' + ab'cd'$$

(b)

i. A fire sprinkler system should spray water if high heat is sensed and the system is set to enabled.

- **Solution:** Let Boolean variable h represent "high heat is sensed," e represent "enabled," and F represent "spraying water." Then an equation is: F = h AND e.

ii. A car alarm should sound if the alarm is enabled, and either the car is shaken or the door is opened.

- **Solution:** Let a represent "alarm is enabled," s represent "car is shaken," d represent "door is opened," and F represent "alarm sounds." Then an equation is: F = a AND (s OR d).
- **Alternatively**, assuming that our door sensor d represents "door is closed" instead of open (meaning d=1 when the door is closed, 0 when open), we obtain the following equation: F = a AND (s OR NOT(d)).

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Q5. (Computer Performance Assessment) Two compliers are used to compile the same benchmark program with the same instruction set architecture (ISA) for the same computer (clock rate=1GHz). There are three classes of instructions in this ISA, and each of them takes different numbers of clock cycles to finish. Class A instruction takes 2 clock cycles to finish, Class B instruction takes 3 clock cycles to finish, and Class C instruction takes 4 clock cycles to finish. The numbers of instructions generated by complier 1 and complier 2 are listed below.

	# of Inst. Generated by Compiler 1	# of Inst. Generated by Compiler 2
Class A (CPI = 2)	5 Millions	1 Millions
Class B (CPI = 3)	2 Millions	2 Millions
Class C (CPI = 4)	1 Millions	2 Millions

The following equation might be helpful:

$$\frac{\text{seconds}}{\text{program}} = \frac{\text{Insructions}}{\text{program}} \times \frac{\text{cycles}}{\text{Instructions}} \times \frac{\text{seconds}}{\text{cycle}}$$

$$= Instructio\,n\ Count \times CPI \times Clock\ C\text{ycle Time}$$

Which compiler makes faster machine code (You must write down your calculation)?

Solution

Clock period= 10^{-9} second

Compiler 1 execution time

$(5\times2+2\times3+1\times4) \times10^{6}\times10^{-9}=0.02$ sec

Compiler 2

$(1\times2+2\times3+2\times4) \times10^{6}\times10^{-9}=0.016$ sec

Compiler 2 is faster

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