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100 ✓

2007 ECE253F Midterm Examination

Examiner: P. Aarabi

1 Question – 100 marks – 1 BONUS
60 minutes – 8 pages

a) 15
b) 10

c) 15

d) 25
e) 35

The Question:

You have been abducted by aliens and brought aboard their spaceship. This entire midterm is a single multi-part question related to your predicament.

(15)

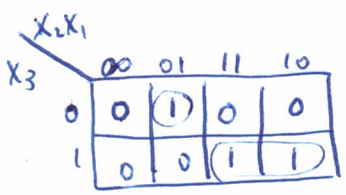
1a. (15 marks)

Finding yourself in a holding cell aboard the alien spaceship, you begin to study the force field that is blocking your cell. You learn that there are four wires on the field control panel (three input, one output) which can turn the field off as long as we have the following input-output relationship:

x3 x2 x1	L
0 0 0	0
0 0 1	1
0 1 0	0
0 1 1	0
1 0 0	0
1 0 1	0
1 1 0	1
1 1 1	1

Use a Karnaugh-Map to find the minimal Sum-of-Products (SOP) logic expression for L in terms of x1, x2, and x3.

L:

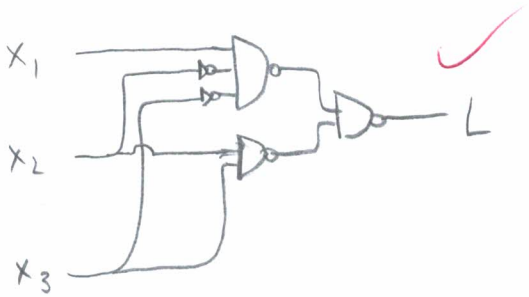


$$L = \bar{X}_3\bar{X}_2X_1 + X_3X_2$$

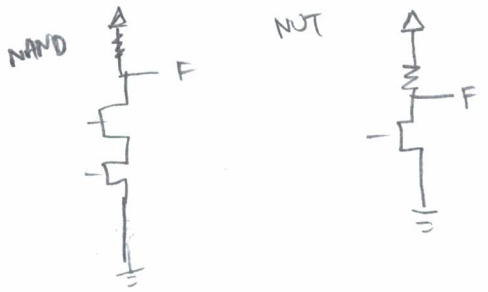
10

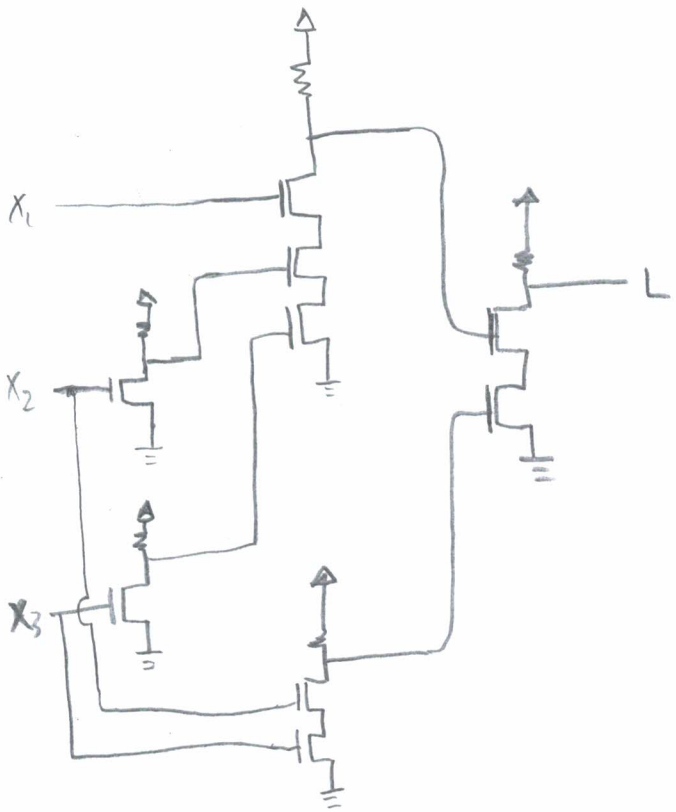
1b. (10 marks)
Convert the logic circuit of 1a. to one that ONLY uses NAND and NOT gates.

$$L = \bar{X}_3 \bar{X}_2 X_1 + X_3 X_2 = \overline{(\overline{\bar{X}_3 \bar{X}_2 X_1})(\overline{X_3 X_2})}$$



1c. (15 marks)
You take lots of NMOS transistors and resistors from your watch. Also, there are 5 Volt power sources all over your cell along with wires. Using all of these items, build the circuit of 1b using only resistors and NMOS transistors.





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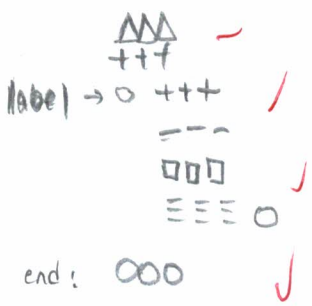
(15)

1d. (25 marks)
Using your field disruptor, you disable the force field and escape your cell. You make it to the alien ship's master computer which you study carefully. You learn the following:

-The alien computer has only a single 1,000,000,000 bit register
-The alien computer uses time shift technology which means every instruction takes very little time to execute
-The alien computer has the following instructions

Instruction	What it does
Δ Δ Δ	Sets the register to 0
+ + +	Adds 1248 to the register
- - -	Subtracts 1250 from the register
□ □ □	Pauses computer for 1 second
Ξ Ξ Ξ LABEL	If register is greater than 0, jumps to LABEL (LABEL can be anything spelled with the alien alphabet O, Ξ, □, Δ, …)
O O O	Explodes the ship

Write an "auto-destruct" assembly program for this alien computer that will explode the ship in approximately 624 seconds.

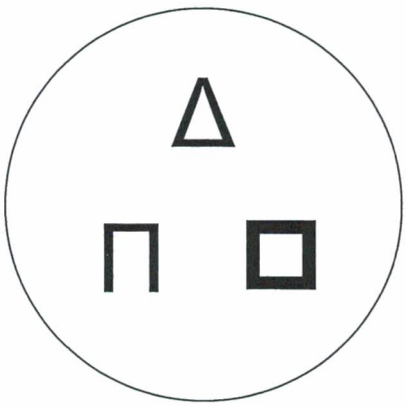


$\frac{1248}{2} = 624$

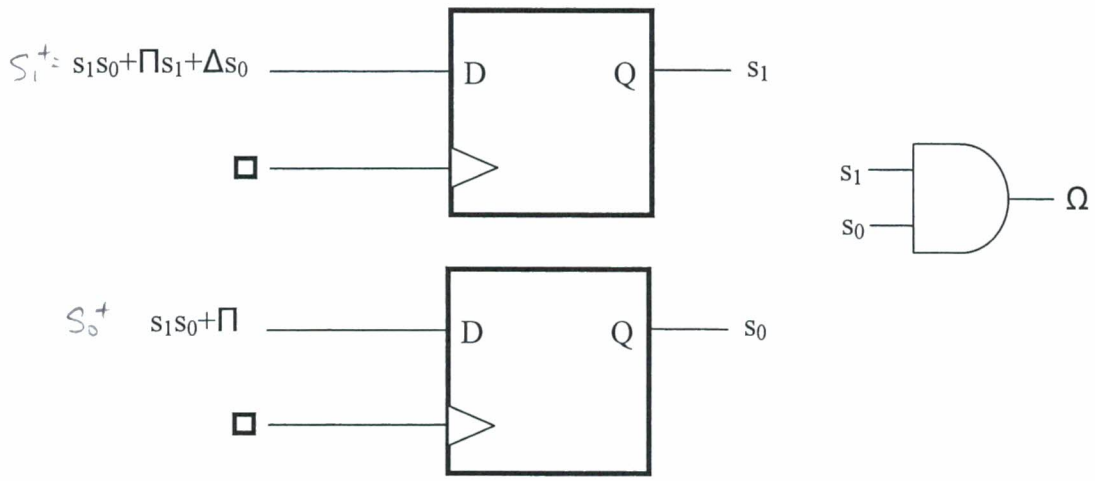
25

1e. (35 marks)
You now have ten minutes left until the ship explodes (and probably, until this midterm ends!!!).

You get to the alien shuttle bay and jump onboard a small space shuttle. On board the space shuttle, you notice a control panel with just three buttons, as shown below:



In a panic, you press various button combinations and NOTHING happens. Then you remember the schematics for this control panel which you had seen in the alien computer. The schematics are as follows:



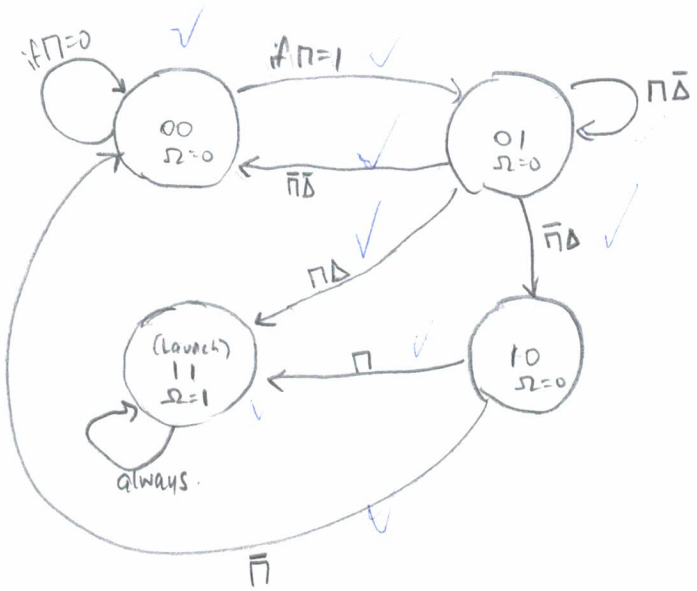
Assume that the buttons Π, Δ, and □ generate a logic 1 value when pressed, and a logic 0 when not pressed. Also, the variable Ω turns on the space shuttle when it has a logic value of 1. **Find the exact combination of buttons to press (including details like when you press and when you release the buttons) in order to turn on the space shuttle (i.e. in order to get Ω to equal 1).**

HINT: Try to get the State Transition Table from the above schematic, and then the State Diagram.

1e. (continued)

$S_1^+ = S_1S_0 + \Pi S_1 + \Delta S_0$ $\quad S_0^+ = S_1S_0 + \Pi$ $\quad \Omega = S_1S_0$

S_1	S_0	Π	Δ	S_1^+	S_0^+	Ω
0	0	0	0	0	0	0
0	0	0	1	0	0	
0	0	1	0	0	1	
0	0	1	1	0	1	
0	1	0	0	0	0	0
0	1	0	1	0	1	
0	1	1	0	1	0	
0	1	1	1	1	1	
1	0	0	0	0	0	0
1	0	0	1	0	0	
1	0	1	0	1	1	
1	0	1	1	1	1	
1	1	0	0	1	1	1
1	1	0	1	1	1	
1	1	1	0	1	1	
1	1	1	1	1	1	



Sequence of keys:

1) Release Δ and Π
2) Press □, release □
3) Hold down Π, press □, release Π
4) Hold down Π and Δ, press □
5) Launch!

35

1f. (BONUS – 5 marks)

You turn on the space shuttle and head back to Earth. You are, however, followed by several alien space fighters. Before you can engage them in a very cool space fight, you need to turn on your lasers. To do so, you must enter a laser-activation code into your shuttle computer.

The code consists of 8 numbers. However, you only remember the first 7 of these when you looked at them on the alien computer. The first seven numbers are:

1 4 9 10 19 24 31 ??

Using everything that you have learned, what is the final (8^{th}) number?

42

X

Pattern is sequence of perfect squares in hexadecimal. next number is 45.