Name : Verdi R-D Student # : 6491419

Question 1

a. In your own words, describe why digital designers attempt to simplify gate arrangements as much as possible through the use of negative logic gates like NAND gates.
b. Show a circuit diagram (made up of discrete logic gates) **and** truth table for how ***NAND gate(s)*** can be used to create :
   i. An AND gate
   ii. An OR gate
   iii. And INVERTER gate

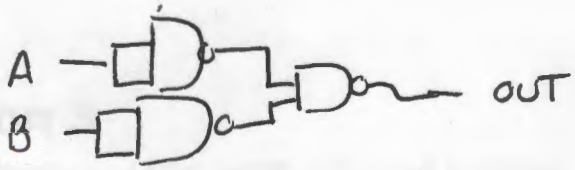
[7 Marks]

a) Digital designers attempt to simplify gate arrangements so they can be flexible later in choosing which gates to use. This lets them use the most inexpensive gate array for their project

b) i)

A	B	OUT
0	0	0
0	1	0
1	0	0
1	1	1

ii)



A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	1

iii)

A	OUT
0	1
1	0

7

60.5/68

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Question 2

Explain **briefly**, but **clearly**: **[4 marks]**

a. What is the general purpose of the ALU ?
b. What is the benefit of twisted pair wiring ?
c. What is the general purpose of the IDU ? In your answer, make sure to tell me what steps the IDU repeats.

a) The alu is the part of the processor which handles basic arithmatic and logic

1

Question 3

7

Answer the following true/false and fill in the blank questions: **[9 marks]**

a. There are 2 nibbles in a byte. ✓
b. In a digital circuit, we use V_{cc} to represent the binary value of 0. (true/false) false ✓
c. Ohm's Law is given by the formula **P = I x V**. (true/false) false ✓
d. A hexadecimal digit can be represented in 4 bits of a binary number. ✓
e. To multiply a number by 8, the ALU shifts the value 3 positions to the right. (true/false) true ✗
f. The lowest order bit of an 8 bit value is also the sign bit. (true/false) false ✓
g. **Any** Boolean value OR'ed with HIGH will result in HIGH. (true/false) true ✓
h. A Boolean equation or expression can be written as a ~~combination~~ sum of ~~gates~~ products (2 words). ✗
i. Subtracting numbers requires the 2nd operand to undergo what conversion before adding it? two's compliment (2 words) ✓

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Question 4

Take the final **2 digits** from your student ID number. Convert this 2 digit number into an **8 bit binary number**. Let this number be represented by XXXXXXXX – now take this value and perform these bitwise operations : **[7 marks]**

<Specify XXXXXXXX below>

00100011_2 ✓ (1 mark for 8 bit binary value)

```
        00100011
AND     11010111
        ========
        00010011
```
✓ (1 mark)

```
        00100011
then OR 01101110
        ========
        01111111
```
✓ (1 mark)

```
        01111111
then XOR 00110111
         ========
         01001000
```
✓ (1 mark)

10110111
10111000

7

Now take the result from above, and do a two's complement operation ~~1010~~ 10111000 ✓ (1 mark)

Also express this value in

Hexadecimal 0x B8 ✓ (1 mark) and in

Decimal 184 ✓ (1 mark)

*Remember bitwise operations are performed on **each** bit of the 8 bit values. For example :*

```
  1011
AND 0110
    ----
  0010
```

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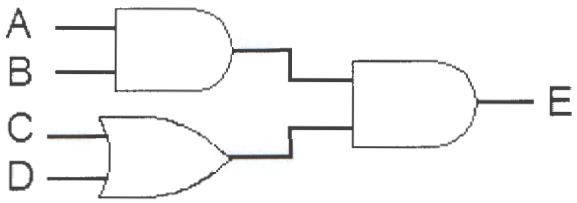
Question 5

The following circuit diagram will be used for the sub questions below: **[11 marks]**



- Write the **truth table** for the above circuit, showing **all possible** input values as well as the output values. (8 marks)
- Write the **Boolean expression** for output E above. (3 marks)

A	B	C	D	E
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

(AB)(C+D)

better written as

(A·B)·(C+D)

11

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Question 6

A fictitious computer system has a **6 bit address bus**, with the following address mapping table: **[15 marks]**

a.	RAM:	$00 to $1F	CS_RAM
b.	ROM:	$20 to $2F	CS_ROM
c.	Status LED	$30	CS_LED
d.	Communications Port:	$32 to $33	CS_COM
e.	LCD Display	$38 to $3F	CS_LCD

- Write the BOOLEAN EXPRESSIONS (in Sum of Products form) for EACH of the above address ranges to generate the appropriate chip select signal as shown above
  - In each case, show plenty of background work (for example, binary values for each hex value, potential gate logic diagram, etc.) to ensure that if you don't get the Boolean expression correct, that at least you will qualify for some part marks by showing your thinking pattern
  - there is a place to do rough work at the end of the exam – I can provide more paper if necessary.
  - Remember to watch for the "*don't cares*"
  - *3 marks for each Boolean expression*

13.5

Address Bus

A B C D E F

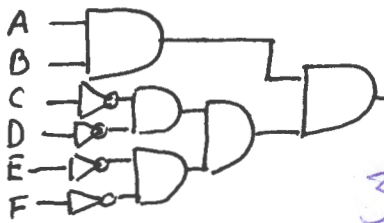
a) RAM $00 - $1F
CS_RAM 000000 011111

→ 3 $\overline{A}$ or "A barred"

b) ROM $20 - $2F
CS_ROM 100000 101111

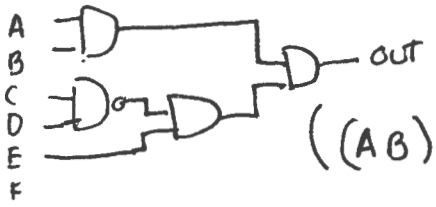
→ 3 (A)(!B) or "A and B barred"

c) Status LED $30
CS-LED 110000



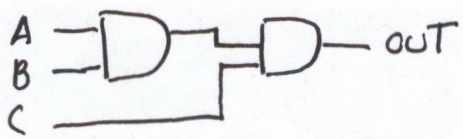
3 ((AB)((!C!D)(!E!F)))

d) Com Port $32 - $33
CS_com 110010 - 110011



((AB)(!(CD)(E))) 2½

e) LCD Display $38 - $3F
CS_LCD 111000 111111



(ABC) 3

-1 for

* Address bus lines labelled A_5 A_4 A_3 A_2 A_1 A_0 not A B C D E F

* Boolean expressions don't use ! for not (or bar) → use $\overline{A}$

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Question 7

Let's work on some calculations! For the following calculations, you can assume (if needed) that the voltage present in a wall-plug in a house is 110 volts. **[6 marks]**

a. How much power is consumed by plugging a toaster into a wall-plug when the toaster draws 5 A ?

$P = I \cdot V$

$P = 5 \cdot 110$

$P = 550\,W$

1.5

b. What voltage must be drawn by a widget device consuming 1500 W of power and drawing 30 A ?

$P = I \cdot U \quad U = \frac{P}{I} \quad U = \frac{1500}{30} \quad U = 50V$

1.5

c. What is the effective resistance of the toaster in (a) above ?

Note: Toasters generally use AC rather than DC so the question should be more impeadance rather than resistance ← thanks for correcting me! :) 1.5

$V = IR \quad R = \frac{V}{I} \quad R = \frac{110}{5} \quad R = 22\,\Omega$ ✓

d. How much power is consumed by an iPod drawing 500 mA with an effective resistance of 10 Ω ?

$\because V = I \cdot R$

$\therefore P = (I \cdot R)(I) = I^2 R$

$P = 500^2 \cdot 10$

$P = 2500 \cdot 10$

$P = 25{,}000\,W$

* 500mA = 0.5A so this # should have been $(0.5)^2$ making the answer 2.5W

1/2

5

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Question 8

Now let's do some number conversions ...

a. Write the following decimal numbers in their 8-bit binary and hexadecimal equivalents **[3 marks]**

Decimal	8-Bit Binary	Hexadecimal
36	00100100 ✓	$24 ✓
153	10011001 ✓	$99 ✓
220	11011100 ✓	$DC ✓

3

b. Write the following hexadecimal numbers in their decimal and binary forms. Use as many bits as you need to in the binary answers. **[3 marks]**

Hexadecimal	Decimal	Binary
0x0F	15 ✓	00001111 ✓
0x1A3	419 ✓	0001 10100011 ✓
0x1010	4112 ✓	0001 0000 0001 0000 ✓

3

c. Write the following binary numbers in their (unsigned) decimal and hexadecimal equivalents. **[3 marks]**

Binary	Decimal	Hexadecimal
000001001100	76 ✓	$04C ✓
11101010	234 ✓	$EA ✓
11111111	255 ✓	$FF ✓

3

9

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---------- ROUGH WORK SPACE BEGINS ----------

128 64 32 16 8 4 2 1

1 0 1 1 1 0 0 0

160 ↓

176 ↓

184

50 x 30

1500

A 1010

B 1011

C 1100

D 1101

E 1110

F 1111

```
  4
 153
-128
 025
  16
  09
```

10011001

```
  11
 220
-128
 088
  64
  24
  16
  08
```

11011100

128 + 64 + 32 + 8 + 2 = 234?

```
  1
 128
+ 64
 192
+ 32
 224
+  8
 232
+  2
 234
```

```
  1
 256
+128
 384
+ 32
 416
+  2
 418
+  1
 419
```

```
   11
 4096
+  16
 4112
```