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CSE 12 Midterm - Version A

Fall 2019

Basic Electronics

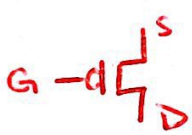
1. One amp is equivalent to which of the following? Recall Ohm's Law.
   - ○ A. 1 *ohm · volt*
   - ○ B. 1 *ohm/watt*
   - ○ C. 1 *ohm/volt*
   - ⊗ D. Answer not listed
   - ○ E. 1 *volt/watt*

V=IR

volt = amp · ohm

$\frac{volt}{ohm} = amp$

2. Fill in the blanks. A PMOS acts as a closed switch when the _____ voltage equals _____.
   - ○ A. collector, 0
   - ○ B. drain, 0
   - ○ C. gate, 1
   - ⊗ D. Answer not listed
   - ○ E. source, 1



when G=0

Integer Numbering Systems

3. Convert the binary number `0b1111` to base 5.
   - ○ A. 15_5
   - ○ B. 40_5
   - ⊗ C. 30_5
   - ○ D. Answer not listed
   - ○ E. 60_5

0b1111 = 15

$30_5 = 15_{10}$

$3 \times 5^1 + 0 \times 5^0 = 15_{10}$

4. Convert the octal number 321_8 to hexadecimal.
   - ○ A. `0x501`
   - ○ B. Answer not listed
   - ⊗ C. `0xD1`
   - ○ D. `0x39`
   - ○ E. `0x209`

321_8

011 010 001

0b011010001

D 1 = 0xD1

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Boolean Algebra

5. Select the Boolean expression that equals $\overline{\overline{(A+BC)}+\overline{A\bar{B}}}$

- A. $\bar{A}BC$
- B. $A\bar{B}$
- C. $ABC+A\bar{B}$
- D. $A+BC$
- E. $A+B$

$X = A+BC$

$Y = A\bar{B}$

$\overline{\overline{A+BC} + \overline{A\bar{B}}}$

$= \overline{\bar{X} + \bar{Y}}$ (substitution)

$= X Y$ (DeMorgans)

$= (A+BC)(A\bar{B})$

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

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

$= A \cdot \bar{B}$

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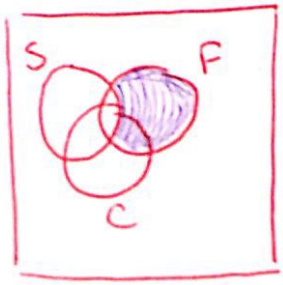
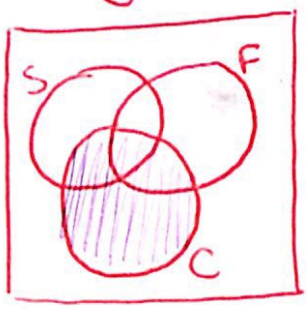
6. The following Boolean expression matches the shaded area of which Venn diagram? Assume shaded areas are where the expression equals true. S = Small, F = Fluffy, and C = Cute.

$$\bar{S}F + C$$

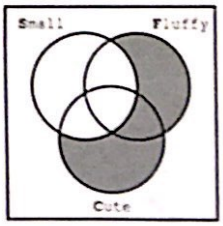
$\bar{S}F$



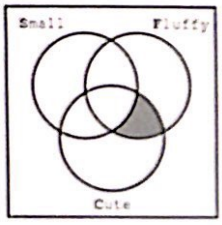
C



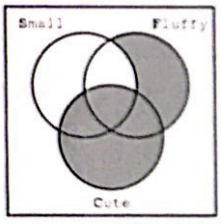
○ A.



○ B.

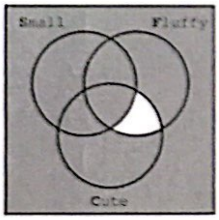


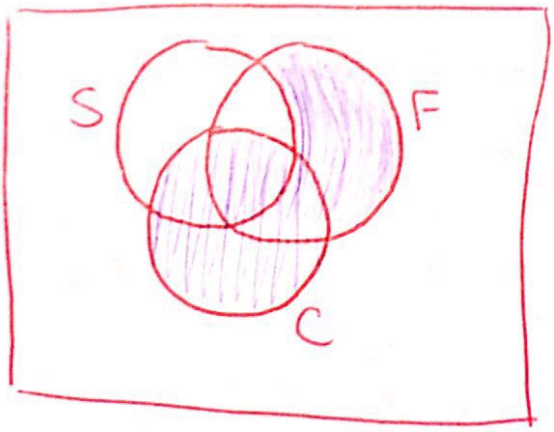
○ C.



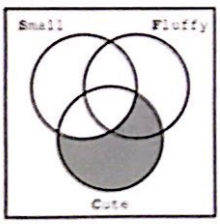
$\bar{S}F + C$

○ D.





○ E.



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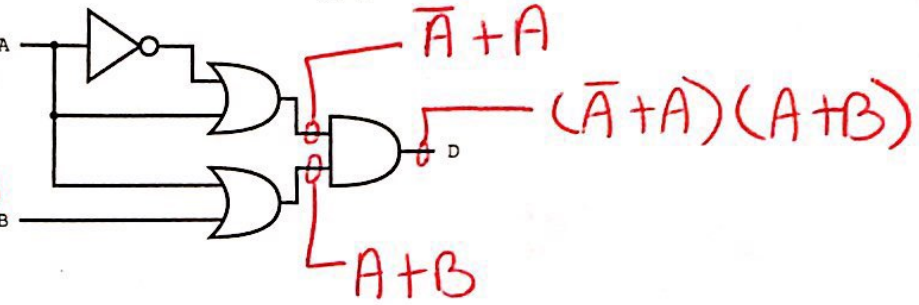
Combinational Logic

7. What is the Boolean expression for the circuit? Select all that apply.

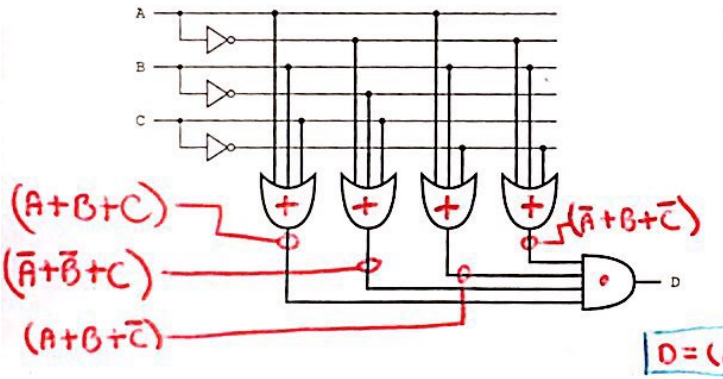
$(\bar{A}+A)(A+B)$
$= 1 \cdot (A+B)$
$= A+B$

$(A+\bar{A})(A+B)$
$= A + \bar{A}B$
(distribution)



- [x] A. $D = \bar{A}B + A$
- [ ] B. $D = \bar{A} + B$
- [ ] C. $D = A$
- [x] D. $D = A + B$
- [ ] E. Answer not listed

8. Select the **sum of products** Boolean expression that describes this circuit. Hint: complete the truth table first.



A	B	C	D	
0	0	0	0	$A+B+C$
0	0	1	0	$A+B+\bar{C}$
0	1	0	1	$\bar{A}B\bar{C}$
0	1	1	1	$\bar{A}BC$
1	0	0	1	$A\bar{B}\bar{C}$
1	0	1	0	$\bar{A}+B+\bar{C}$
1	1	0	0	$\bar{A}+\bar{B}+C$
1	1	1	1	ABC

$D = (A+B+C)(\bar{A}+\bar{B}+C)(A+B+\bar{C})(\bar{A}+B+\bar{C})$ ← product of sums

- [ ] A. $D = (A+B+\bar{C})(A+\bar{B}+C)(\bar{A}+\bar{B}+C)(\bar{A}+\bar{B}+\bar{C})$
- [ ] B. $D = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + A\bar{B}C + AB\bar{C}$
- [x] C. $D = \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}\bar{C} + ABC$
- [ ] D. $D = \bar{A}\bar{B}C + AB\bar{C} + A\bar{B}C + ABC$
- [ ] E. $D = (\bar{A}+B+C)(\bar{A}+B+\bar{C})(A+\bar{B}+\bar{C})(A+B+C)$

$D = \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}\bar{C} + ABC$

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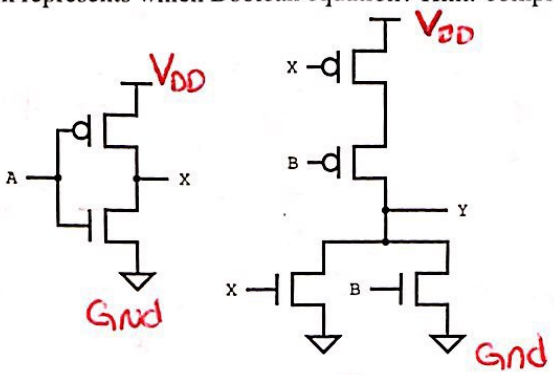
9. The following CMOS diagram represents which Boolean equation? Hint: complete the truth table first.

A	X
0	1
1	0

$\Rightarrow X = \overline{A}$



X	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

$\Rightarrow Y = \overline{X+B}$

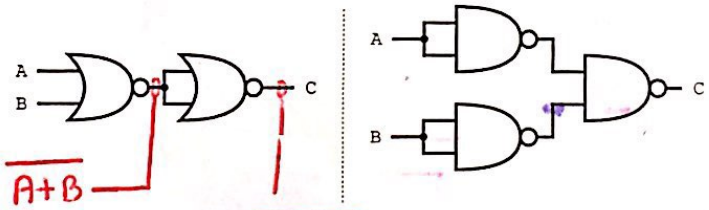
- ☒ A. $Y = \overline{\bar{A}+B}$
- ○ B. $Y = \bar{A}+B$
- ○ C. Answer not listed.
- ○ D. $Y = AB$
- ○ E. $Y = \overline{\bar{A}B}$

$Y = \overline{X+B}$

$X = \overline{A}$

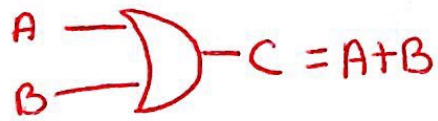
$\Rightarrow Y = \overline{\overline{A}+B}$

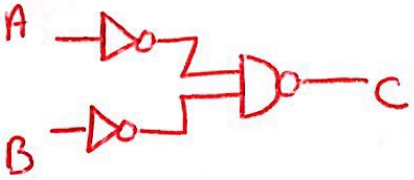
10. True or False: These two circuits are logically equivalent.



$\overline{(\overline{A+B})+(\overline{A+B})}$

- ☒ A. True
- ○ B. False





$\overline{\bar{A}\cdot\bar{B}} = C$

$\overline{\bar{A}\cdot\bar{B}} = A+B$ (deMorgans)

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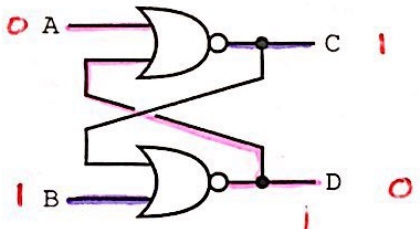
11. What is the **product of sums** solution to this truth table?

A	B	C	D	
0	0	0	1	
0	0	1	0	← $A+B+\bar{C}$
0	1	0	1	
0	1	1	1	
1	0	0	0	← $\bar{A}+B+C$
1	0	1	0	← $\bar{A}+B+\bar{C}$
1	1	0	1	
1	1	1	1	

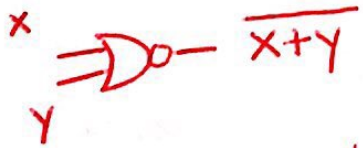
- ○ A. $D = \bar{A}\bar{B}\bar{C}+\bar{A}B\bar{C}+\bar{A}BC+AB\bar{C}+ABC$
- ⊗ B. $D = (A+B+\bar{C})(\bar{A}+B+C)(\bar{A}+B+\bar{C})$
- ○ C. $D = B+\bar{A}\bar{C}$
- ○ D. $D = (\bar{A}+\bar{B}+\bar{C})(\bar{A}+B+\bar{C})(\bar{A}+B+C)(A+B+\bar{C})(A+B+C)$
- ○ E. $D = \bar{A}\bar{B}C+A\bar{B}\bar{C}+A\bar{B}C$

Sequential Logic

12. Assume values A and B are 0 and 1, respectively. What are the values on wires C and D, respectively?



- ○ A. 1, 1
- ○ B. There is not enough information to answer
- ⊗ C. 1, 0
- ○ D. 0, 1
- ○ E. 0, 0

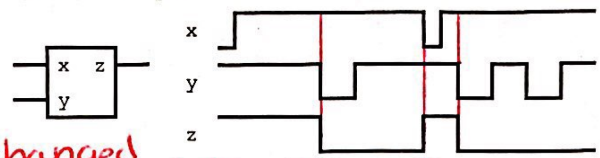


X	Y	X+Y	$\overline{X+Y}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

⇒ If either input in a NOR gate is 1, the output is 0

For timing diagrams, look when output changes. Make an assumption and use process of elimination

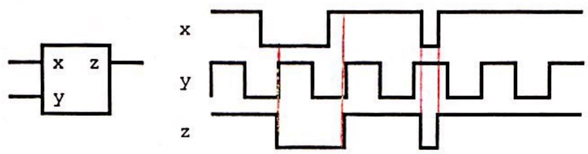
13. What device does this timing diagram represent?



output changed when y went low ↑ ↑ output changed when x went low

- ⊗ A. S-R Latch, active low
- ○ B. D Flip-Flop, rising edge triggered
- ○ C. S-R Latch, active high
- ○ D. Answer not listed
- ○ E. D Flip-Flop, falling edge triggered

14. What device does this timing diagram represent?



output matches x when y is high

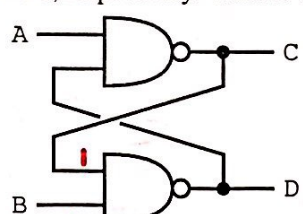
- ⊗ A. D Latch
- ○ B. Answer not listed
- ○ C. S-R Latch, active high
- ○ D. D Flip-Flop, falling edge triggered
- ○ E. S-R Latch, active low

15. Assume values on wires C and D are 1 and 0, respectively. What is the value on wire B?

$x, y \to \overline{xy}$

xy	$\overline{xy}$
00	1
01	1
10	1
11	0

The output from a NAND gate is 0 iff both inputs are 1



1 (C), 0 (D)

↑ B must be 1 for D to be zero

- ⊗ A. 1
- ○ B. There is not enough information to answer
- ○ C. 0

Data Representation

16. Convert the 8-bit two's complement number `0xF6` to 12-bit sign magnitude representation.

- ○ A. `0x0F6`
- ⊗ B. `0x80A`
- ○ C. `0xFF6`
- ○ D. Answer not listed
- ○ E. `0x806`

0xF6 = 0b11110110 ← negative

what is additive inverse of 0xF6?

invert bits: 0b00001001

add 1: 0b00001010

0x0A (ten) is the additive inverse of 0xF6

so... 0xF6 (in 2SC) is −10 → −10 in 12-bit S.M. is: 0b100000001010 = 0x80A

17. What is the most positive number that can be represented in 7-bit two's complement? Answers are expressed in decimal.
    - ○ A. 64
    - ○ B. 31
    - ⊗ C. 63
    - ○ D. 128
    - ○ E. 32

range: $-2^{n-1} \rightarrow 2^{n-1}-1$

$n=7 \quad 2^{7-1}-1 = 2^6-1 = 64-1 = 63$

18. The number 17.5_{10} (which is equivalent to $1.00011 \cdot 2^4$) is stored in IEEE 754 single precision floating point format. What is contained in the exponent field? Recall that the exponent field is 8 bits, stored in bias 127 representation.
    - ⊗ A. 0x83
    - ○ B. 0x04
    - ○ C. 0xFC
    - ○ D. 0x23
    - ○ E. 0x84

$1.00011 \times 2^4 \leftarrow$ exp

put 4 in 8-bit bias 127 notation

=> add 127

$4+127 = 131 = 0b10000011 = 0x83$

19. What is the minimum number of bits needed to represent the unsigned number 128?
    - ○ A. 9
    - ⊗ B. 8
    - ○ C. 7
    - ○ D. Answer not listed
    - ○ E. 10

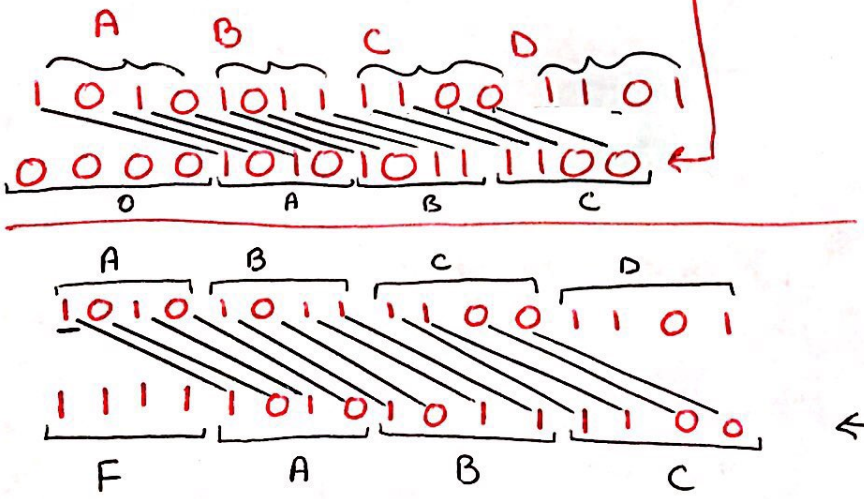
$128 = 2^7 = 0b10000000$

Arithmetic and Logical Operations

20. What is the result of a shift right logical (SRL) by four and a shift right arithmetic (SRA) by four of the 16-bit number 0xABCD? The operations are performed independently of each other.
    - ○ A. SRL: 0x0ABC SRA: 0xDABC
    - ⊗ B. SRL: 0x0ABC SRA: 0xFABC
    - ○ C. SRL: 0xDABC SRA: 0x0ABC
    - ○ D. SRL: 0xFABC SRA: 0x0ABC
    - ○ E. Answer not listed

logical: shift in zeros

arithmetic: shift in MSB



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21. Which of these 8-bit two's complement computations has overflow and no carry out? Select all that apply.

○ A.
```
  0x 8 A
+ 0x 8 F
--------
```

○ B.
```
  0x E A
+ 0x C B
--------
```

○ C.
```
  0x F F
+ 0x E E
--------
```

✓ D.
```
  0x 7 C
+ 0x 0 B
--------
```

○ E.
```
  0x 8 1
+ 0x 9 5
--------
```

If most significant digits add up to 16 or greater, there will be carry out!
Answers A, B, C, E will all have carry out.

Let's check D:

```
  1
0x 7 C  ← C=12
0x 0 B  ← B=11
--------
0x 8 7   23 = 0x17
```

0x7C = 0b01111100 (positive)

0x0B = 0b00001011 (positive)

0x87 = 0b10000111 (negative) => we have overflow!

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Command Line Interface

Consider the following file structure:

```
top
|
|--- Lab0
|      |---- README.txt
|
|--- Lab1
|      |---- Lab1.lgi
|      |---- README.txt
|
|--- Lab4
       |---- FlowChart.pdf
       |---- Lab4.asm
```

22. Given the stated directory structure, assume the command `ls` prints `FlowChart.pdf Lab4.asm` to the screen. What is printed to the screen after the following commands are executed?

```
rm *
touch a.txt
mv a.txt b.txt
cd ..
ls Lab4
```

- ○ A. `b.txt Flowchart.pdf Lab4.asm`
- ○ B. `a.txt b.txt`
- ⊗ C. `b.txt`
- ○ D. Answer not listed
- ○ E. `Flowchart.pdf Lab4.asm`

we start in directory Lab 4

command	contents of Lab 4 after command
rm *	(empty)
touch a.txt	a.txt
mv a.txt b.txt	b.txt
cd ..	b.txt
ls Lab4	b.txt