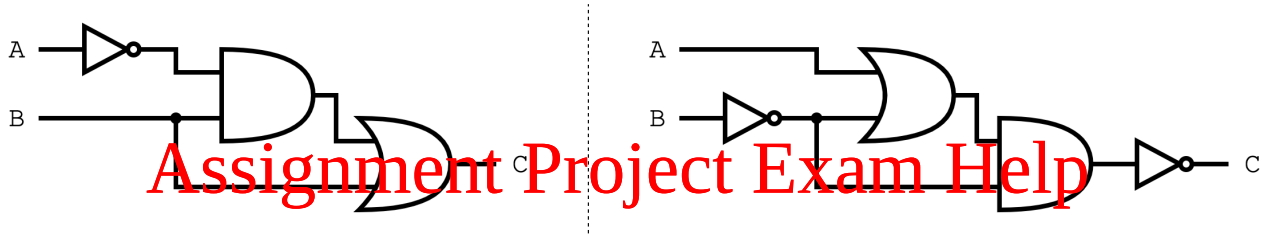
CruzID: _____ @ucsc.edu

CMPE 12 Final - Version A

Spring 2019

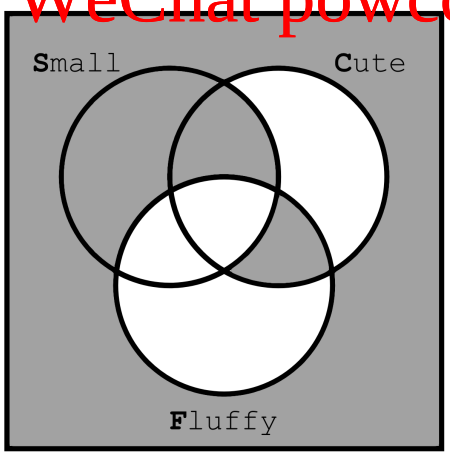
Combinational Logic & Boolean Algebra

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



- (X) A. True
- ( ) B. False

2. Select the Boolean expression(s) matching the grey-filled areas of this Venn diagram.

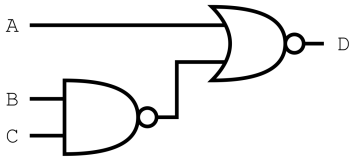


- ( ) A. $SCF + \bar{S}C\bar{F} + S\bar{C}F + \bar{S}\bar{C}F$
- ( ) B. $SCF + \bar{C}F + \bar{S}C\bar{F}$
- (X) C. $\bar{S}\bar{C}\bar{F} + S\bar{F} + \bar{S}FC$
- ( ) D. Correct answer not listed
- ( ) E. $\bar{S}\bar{C}\bar{F} + \bar{S}F + S\bar{F}C + CF$

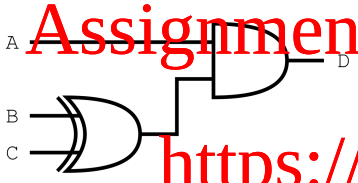
3. Which circuit matches this truth table?

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

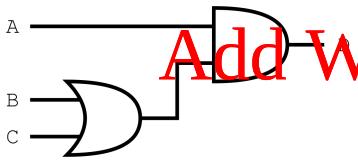
○ A.



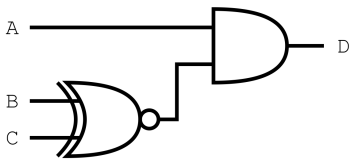
⊗ B.



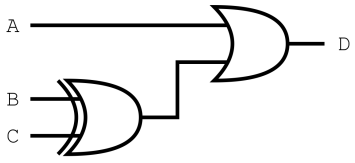
○ C.



○ D.

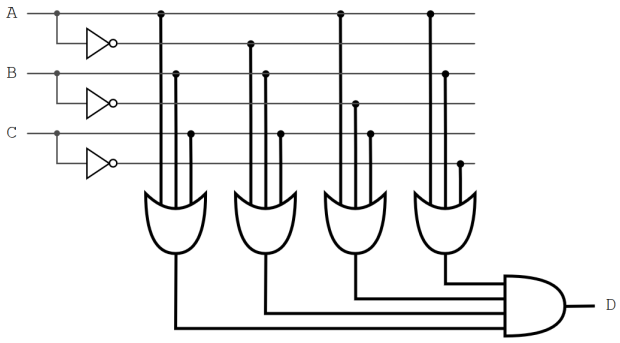


○ E.



4. What kind of multiplexor has 3 select lines?
   - ◯ A. 3-to-1
   - ◯ B. 2-to-1
   - ◯ C. 16-to-1
   - ⊗ D. 8-to-1
   - ◯ E. 9-to-1

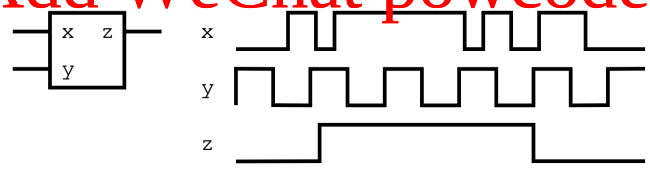
5. What equation does this PLA represent?



   - ◯ A. $(\bar{A}+B+C)(A+\bar{B}+\bar{C})(A+B+C)(\bar{A}+\bar{B}+\bar{C})$
   - ◯ B. $(\bar{A}+\bar{B}+\bar{C})(A+B+\bar{C})(\bar{A}+B+\bar{C})(\bar{A}+\bar{B}+C)$
   - ◯ C. $(\bar{A}+\bar{B}+C)(A+B+\bar{C})(A+\bar{B}+\bar{C})(A+\bar{B}+C)$
   - ◯ D. $(A+B+C)(A+\bar{B}+\bar{C})(\bar{A}+B+\bar{C})(\bar{A}+\bar{B}+C)$
   - ⊗ E. $(A+B+C)(\bar{A}+B+C)(A+\bar{B}+C)(A+B+\bar{C})$

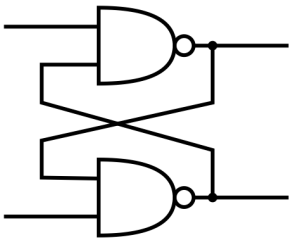
Sequential Logic

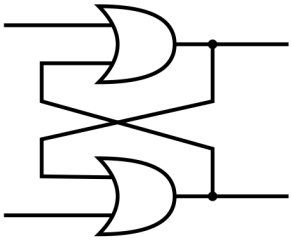
6. What device does this timing diagram represent?

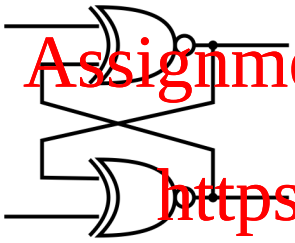


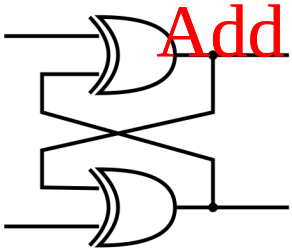
   - ⊗ A. D flip flop, edge triggered
   - ◯ B. D-R latch
   - ◯ C. D latch, level triggered
   - ◯ D. S-R latch, active high
   - ◯ E. S-R latch, active low

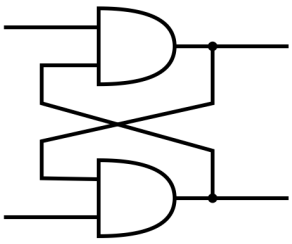
7. Which of the following circuits can form a latch?

⊗ A. 

○ B. 

○ C. 

○ D. 

○ E. 

CruzID: _____ @ucsc.edu

Integers

8. What is 1230_4 in base 32? Assume $A_{32} = 10$, $B_{32} = 11$, ... , $G_{32} = 16$, etc.
   - (X) A. $3C_{32}$
   - ( ) B. $3D_{32}$
   - ( ) C. BT_{32}
   - ( ) D. $3C0_{32}$
   - ( ) E. $4D_{32}$

9. What is the range of values for an integer in 8-bit sign-magnitude representation?
   - ( ) A. -127 to 128
   - (X) B. -127 to 127
   - ( ) C. 0 to 255
   - ( ) D. -128 to 127
   - ( ) E. -128 to 128

10. Extend the following 4-bit sign-magnitude value to 8-bits: `0b1101`
    - ( ) A. `0b11111101`
    - ( ) B. `0b00001101`
    - ( ) C. `0b10001101`
    - (X) D. `0b10001101`
    - ( ) E. `0b00001101`

11. What is the decimal equivalent of the 8-bit two's complement number `0b10010111`?
    - (X) A. -105
    - ( ) B. -151
    - ( ) C. 151
    - ( ) D. 105
    - ( ) E. -104

12. Convert 210_3 to base 5.
    - ( ) A. 21_5
    - ( ) B. 41_{10}
    - ( ) C. 210_5
    - ( ) D. 211_5
    - (X) E. 41_5

13. What is the lowest number that can be represented using 8-bit bias 127 representation?
    - ( ) A. 127
    - (X) B. -127
    - ( ) C. -256
    - ( ) D. 0
    - ( ) E. -128

14. Convert the 8-bit two's complement number `0b11001101` to 8-bit sign-magnitude representation.
    - ( ) A. `0b11001100`
    - ( ) B. `0b01001100`
    - ( ) C. `0b00110011`
    - ( ) D. `0b01001101`
    - (X) E. `0b10110011`

15. What is the largest unsigned integer a 6-bit register can hold?
    - ◯ A. `0x8`
    - ◯ B. `0xF`
    - ◯ C. `0xFF`
    - ◯ D. `0xFFF`
    - ⊗ E. `0x3F`

Fractions & Floating Point

16. Which IEEE 754 single precision floating point number is furthest from zero?
    - ◯ A. `0x4479C000`
    - ⊗ B. `0xC47A0000`
    - ◯ C. `0x41300000`
    - ◯ D. `0xC25C0000`
    - ◯ E. `0x431B0000`

17. Convert the decimal value 51.8_{10} to unsigned fractional binary
    - ⊗ A. $110011.\overline{1100}$
    - ◯ B. 110011.0001
    - ◯ C. 110011.1000
    - ◯ D. 110011.1100
    - ◯ E. $110011.\overline{0001}$

18. Which IEEE 754 single precision floating point number has the largest positive exponent?
    - ◯ A. `0x42903333`
    - ⊗ B. `0x43F7999A`
    - ◯ C. `0xC3018000`
    - ◯ D. `0xC2366666`
    - ◯ E. `0x425A6666`

19. Convert the floating point number `0x40400000` to unsigned binary.
    - ◯ A. `0b101`
    - ◯ B. `0b001`
    - ⊗ C. `0b011`
    - ◯ D. `0b110`
    - ◯ E. `0b010`

Strings

20. What is printed to the screen in this MIPS program?

```
.data
P1: .space 27
P2: .asciiz "ABCDEFGHIJKLMNOPQRSTUZWXYZ"

.text
L1:   la   $t0, P1
      addi $t1, $zero, 26
      addi $t2, $zero, 97    # ascii value for 'a'

L2:   sb   $t2, ($t0)
      addi $t1, $t1,   -1
      beqz $t1, GLUE
      addi $t0, $t0,    1    # increment address
      addi $t2, $t2,    1    # increment ascii value
      b    L2

GLUE: li   $v0, 4
      la   $a0, P1
      syscall

      li   $v0, 10
      syscall
```


- (X) A. abcdefghijklmnopqrstuvwxyz
- ( ) B. ABCDEFGHIJKLMNOPQRSTUZWXYZ
- ( ) C. Correct answer not listed; runtime error
- ( ) D. abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUZWXYZ
- ( ) E. 27

21. Decode the following ASCII string. Values are given in hex:

`49 20 68 61 76 65 20 74 68 65 20 68 69 67 68 20 67 72 6f 75 6e 64 21.`

- (X) A. I have the high ground!
- ( ) B. I have no idea what the other sentences mean.
- ( ) C. It's over Anakin!
- ( ) D. You underestimate my power!
- ( ) E. Don't try it.

CruzID: _____ @ucsc.edu

Arithmetic & Logical Operations

22. What is the result of a bit-wise XOR performed on the following 8-bit binary numbers:

```
  0b 1 0 1 1 0 1 1 0
⊕ 0b 1 0 1 0 1 0 1 0
_____________________
```

- ◯ A. 0b01000001
- ⊗ B. 0b00011100
- ◯ C. 0b10111110
- ◯ D. 0b11100011
- ◯ E. 0b10100010

23. What is the result of a shift right arithmetic by three and a shift right logical by three of the 8-bit number 10010110 = 0x96? The operations are performed independently of each other.

- ◯ A. 0x12 and 0x12
- ◯ B. 0xB0 and 0xB7
- ◯ C. 0x12 and 0xF2
- ◯ D. 0xF7 and 0xB0
- ⊗ E. 0xF2 and 0x12

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

- ◯ A. 0x80 + 0x80 = 0x00
- ⊗ B. 0xFB + 0xCC = 0xC7
- ◯ C. 0x7F + 0x70 = 0xEF
- ⊗ D. 0x89 + 0xFF = 0x88
- ⊗ E. 0xA7 + 0x61 = 0x08

Memory

25. Assume a little endian memory system. What is stored in $s0 after the following program is executed?

```
.data
flux:            .word  0xC0FFEEEE
some_data:       .byte  0xFE 0xED 0xBB
some_more_data: .byte  0xCE    1    2 0x00

.text
la  $t1   some_more_data
lw  $t0   ($t1)
sb  $t0  2($t1)
lw  $s0   ($t1)
```

- ◯ A. 0x00CE01CE
- ◯ B. 0x000200CE
- ⊗ C. Answer not listed; memory alignment error
- ◯ D. 0xCE010000
- ◯ E. 0xCE01CE00

26. How many bits are needed to represent the address in a byte-addressable memory space with capacity of 5TB?
    - (X) A. 43
    - ( ) B. Correct answer not listed
    - ( ) C. 33
    - ( ) D. 20
    - ( ) E. 40

27. How many 32-bit integers can be stored in the array labeled `myArray` as shown below:

```
.data
msg:       .asciiz "Good luck!!"
myArray:   .space 20
tacos:     .asciiz "Tacos and 2SC make me happy!!"
```

    - ( ) A. 80
    - (X) B. 5
    - ( ) C. 4
    - ( ) D. 10
    - ( ) E. 2.5

MIPS Instruction Set Architecture

28. How can we create a mask for bits 4:14 of `$t0`?
    - (X) A. `andi $t0 $t0 0x7ff0`
    - ( ) B. `andi $t0 $t0 0x800f`
    - ( ) C. `ori  $t0 $t0 0x800f`
    - ( ) D. `ori  $t0 $t0 0x7ff0`
    - ( ) E. `xori $t0 $t0 0x7ff0`

29. What is the value in `$10` after the following instructions are executed?

```
ADDI  $10 $0  11
SLL   $10 $10 30
SRL   $10 $10 29
```

    - (X) A. `0xFFFE`
    - ( ) B. `0xFFFF`
    - ( ) C. `0x000B`
    - ( ) D. `0x000F`
    - ( ) E. `0x000E`

30. Decode the following MIPS instruction. Select all that apply.

`0x8D090008`

    - ( ) A. `sw   $8  8($9)`
    - ( ) B. `addi $8  $9  8`
    - (X) C. `lw   $t1 8($t0)`
    - ( ) D. `sw   $t1 8($t0)`
    - ( ) E. `lw   $t0 8($t1)`

31. Assume `$s0=0x6` and `$t7=0xA`. What value is stored in `$t7` after the following instruction?

```
div $t7 $s0
```

- ◯ A. `0x1`
- ◯ B. `0x6`
- ◯ C. `0x4`
- ◯ D. `0x0`
- ⊗ E. `0xA`

32. Decode the following MIPS instruction. Select all that apply.

```
0x012F4020
```

- ⊗ A. `ADD $8 $9 $15`
- ◯ B. `AND $9 $15 $8`
- ◯ C. `ADD $t1 $t7 $t0`
- ⊗ D. `ADD $t0 $t1 $t7`
- ◯ E. `ADD $9 $15 $8`

33. What is the size of a register in MIPS32? Select all that apply.

- ◯ A. 64 bits
- ◯ B. 8 bytes
- ⊗ C. 32 bits
- ⊗ D. 8 nybbles
- ⊗ E. 4 bytes

34. What is the value in `$t0` after the following instructions are executed?

```
li  $t0, 5
li  $t1, 10
xor $t0, $t0, $t0

loop: nop
addi  $t0, $t0,  1
subi  $t1, $t1,  1
bgtz  $t1, loop

li $v0, 10
syscall
```

- ◯ A. 16
- ◯ B. 15
- ⊗ C. 10
- ◯ D. 5
- ◯ E. 0

35. What is the value of register `$v0` after the following instructions?

```
    addi $t1 $zero 8
    addi $s0 $zero 50        # 50 = 0b110010
    addi $v0 $zero 0
loop: nop
    andi $a0  $s0  0
    add  $v0  $v0  $a0
    srl  $t1  $t1  1
    bnez $t1  loop
```

- ◯ A. 2
- ◯ B. 20
- ◯ C. 18
- ⊗ D. 0
- ◯ E. 50

Stack & Subroutines

36. Which instruction will the program counter point to after the "jr $ra" instruction executes in the Prompt_user subroutine?

```
.data
P1: .asciiz "Input: "
N1: .word

.text
      la  $a0, P1
      la  $a1, N1
      jal Prompt_user

halt: li  $v0, 10
      syscall

PrintString:
      li   $v0, 4
      syscall
      jr   $ra

Prompt_user:
      jal  PrintString
      move $a0, $a1
      li   $v0, 8
      syscall
      jr   $ra
```


- ◯ A. `jal Prompt_user`
- ◯ B. `jal PrintString`
- ⊗ C. `move $a0, $a1`
- ◯ D. Answer not listed; code doesn't assemble
- ◯ E. `halt: li $v0, 10`

37. Which combination of MIPS instructions perform a push operation of two elements (in $t0 and $t1) on the stack? Select all that apply.

○ A.
```
sw   $t0,  ($sp)
sw   $t1, 4($sp)
subi $sp,   $sp, 8
```

⊗ B.
```
subi $sp,   $sp, 8
sw   $t0,  ($sp)
sw   $t1, 4($sp)
```

⊗ C.
```
subi $sp,   $sp, 4
sw   $t0,  ($sp)
subi $sp,   $sp, 4
sw   $t1,  ($sp)
```

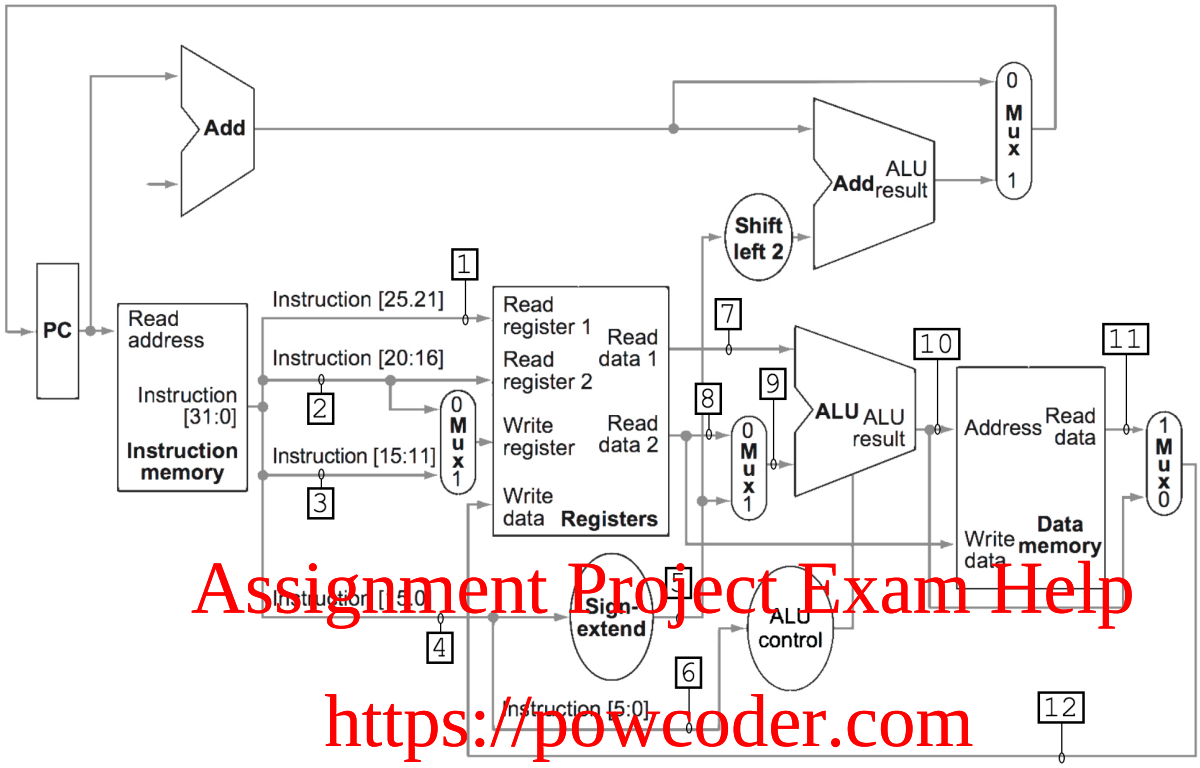
○ D.
```
lw   $t0,  ($sp)
lw   $t1,  ($sp)
addi $sp,   $sp, 8
```

○ E.
```
addi $sp,   $sp, 4
lw   $t0,  ($sp)
addi $sp,   $sp, 4
lw   $t1,  ($sp)
```

CruzID: _____ @ucsc.edu

Data Path

Refer to this MIPS data path for the next three questions:



38. Assume $s0 = 0xAB, $s1 = 0x11 and `SH $s1 8($s0)` is executed. What is the value on wire '8'?
    - ◯ A. Not enough information given.
    - ⊗ B. `0x11`
    - ◯ C. `0xAB`
    - ◯ D. `0x08`
    - ◯ E. `0x10`

39. Assume instruction `0x150802C3` is executed. What is the value on wire '4'?
    - ◯ A. `0x0B0C`
    - ◯ B. `0x10`
    - ◯ C. Not enough information given.
    - ⊗ D. `0x02C3`
    - ◯ E. `0x11`

40. Assume the values on wires '1', '5', '10', '11' and '12' are `0x08`, `0x10`, `0xAF`, `0xBE` and `0xBE` respectively. Which instruction could correspond to these values?
    - ◯ A. `LW   $s0  16($s0)`
    - ◯ B. `ADDI $t0  $t0     0x10`
    - ⊗ C. `LB   $t1  16($t0)`
    - ◯ D. `LH   $7   10($8)`
    - ◯ E. Not enough information given.

Command Line Interface

41. True or False: Listing the files of a different directory changes the directory you are in.
    - (X) A. False
    - ( ) B. True

42. True or False: The command 'mv' can be used to rename a file.
    - (X) A. True
    - ( ) B. False