Last Name: _____   First Name: _____

CruzID: _____

Midterm Exam

CMPE 012: Computer Systems and Assembly Language

University of California, Santa Cruz

Fall 2018

DO NOT BEGIN UNTIL YOU ARE TOLD TO DO SO.

This exam is closed book and closed notes. Only 4-function calculators are permitted. Answers must be marked on the Scantron form to be graded. All work must be written on the exam.

Write your first name, last name, and CruzID on this page. Write your CruzID on all subsequent pages. Fill in the test version on the Scantron form.

You must sit in your assigned seat. Keep your student or government issued ID on your desk. Brimmed hats must be removed or turned around backwards. Only unmarked water bottles are permitted. Backpacks must be placed at the front of the room. Your cell phone must be on a setting where it will not make noise or vibrate.

All questions are multiple choice. Some questions have more than one correct answer. You must mark all correct answers to receive credit for a question.

You have 85 minutes to complete this exam.

Name: _____ Account: _____ @ucsc.edu

CMPE 12 Midterm - VERSION A

Fall 2018

Introduction

1. Which levels of abstraction are lower than natural language? Select all that apply.
   - ○ A. Logic Circuits
   - ○ B. Problems
   - ○ C. Microarchitecture
   - ○ D. Algorithms
   - ○ E. Devices

2. Ada Augusta worked with which mathematician on the Analytical Engine?
   - ○ A. Grace Hoppper
   - ○ B. Joseph Marie Jacquard
   - ○ C. Charles Babbage
   - ○ D. Wilhelm Schickard
   - ○ E. Blaise Pascal

Numbering Systems

3. Which of the following is the correct 4-digit unsigned base 3 representation of 24_{10}?
   - ○ A. 0220_3
   - ○ B. 0122_3
   - ○ C. 2021_3
   - ○ D. 0022_3

4. Convert 0244_5 to base 6.
   - ○ A. 0101_6
   - ○ B. 0202_6
   - ○ C. 0352_6
   - ○ D. 0071_6

5. Convert 0xFAD to octal.
   - ○ A. 2307_8
   - ○ B. 7433_8
   - ○ C. 7655_8
   - ○ D. 4289_8

6. Convert the number 404_5 to base 3.
   - ○ A. 10121_3
   - ○ B. 10212_3
   - ○ C. 12021_3
   - ○ D. 11212_3

Data Representation

7. Which IEEE 754 Single Precision floating point numbers are additive inverses of each other? (Select two)
   - ○ A. 0x41200000
   - ○ B. 0x37DFFFFF
   - ○ C. 0x0000000A
   - ○ D. 0xC1200000
   - ○ E. 0x37700000

8. Convert -71_{10} to 8-bit signed magnitude representation.
   - ○ A. 10111011_2
   - ○ B. 11000111_2
   - ○ C. 10111001_2
   - ○ D. 11010011_2
   - ○ E. 01110111_2

9. Sign extend the 8-bit two's complement number 11000110_2 to a 16-bit two's complement number.
   - ○ A. 1100110011111111_2
   - ○ B. 0000000000111010_2
   - ○ C. 1111111111000110_2
   - ○ D. 0000000011000110_2
   - ○ E. 1000000011000110_2

10. What is the 8-bit two's complement sign-extended representation of this 4-bit unsigned binary number: '1100'
    - ○ A. 11110111_2
    - ○ B. 10001100_2
    - ○ C. 11111100_2
    - ○ D. 11101100_2
    - ○ E. 00001100_2

11. Which IEEE 754 Single Precision floating point number is closest to zero?
    - ○ A. 0x442CCCCD
    - ○ B. 0x385E5D4B
    - ○ C. 0x782CCCCC
    - ○ D. 0xC1200000
    - ○ E. 0x2F9FD394

12. Convert -82_{10} to 8-bit two's complement representation.
    - ○ A. 10110111_2
    - ○ B. 10101110_2
    - ○ C. 01010010_2
    - ○ D. 11001001_2
    - ○ E. 01001001_2

Boolean Algebra

13. Select the Boolean expressions that share the same truth table as

$$\overline{A} \cdot \overline{B} \cdot C + \overline{A} \cdot B \cdot C + A \cdot \overline{B} \cdot C + A \cdot B \cdot C$$
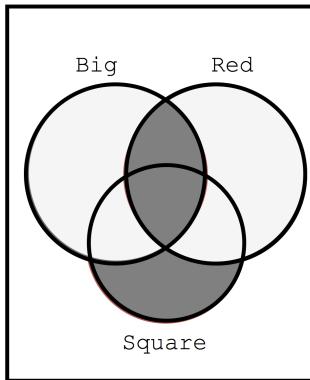
Select all that apply.
- ○ A. $\overline{A} \cdot \overline{B} \cdot \overline{C} + \overline{A} \cdot B \cdot \overline{C} + A \cdot \overline{B} \cdot \overline{C} + A \cdot B \cdot \overline{C}$
- ○ B. $(A + B + \overline{C}) \cdot (A + \overline{B} + \overline{C}) \cdot (\overline{A} + B + \overline{C}) \cdot (\overline{A} + \overline{B} + \overline{C})$
- ○ C. $(A + B + C) \cdot (A + \overline{B} + C) \cdot (\overline{A} + B + C) \cdot (\overline{A} + \overline{B} + C)$
- ○ D. $(\overline{A} + \overline{B} + C) \cdot (\overline{A} + B + C) \cdot (A + \overline{B} + C) \cdot (A + B + C)$
- ○ E. $\overline{(A + B + C)} \cdot \overline{(A + \overline{B} + C)} \cdot \overline{(\overline{A} + B + C)} \cdot \overline{(\overline{A} + \overline{B} + C)}$

14. Select all equivalent Boolean equations.
- ○ A. $B + A\overline{C}$
- ○ B. $AB + A\overline{C} + BC + B\overline{C}$
- ○ C. $(\overline{A} + \overline{B})(\overline{A} + C)(\overline{B} + \overline{C})(\overline{B} + C)$
- ○ D. $AB + A\overline{C} + C$

15. Select the Boolean expression(s) matching the filled areas of this Venn diagram.

- ○ A. $(Big + Red) + Square \cdot \overline{(Big \cdot Red)}$
- ○ B. $(Big \cdot Red) \cdot (Square + \overline{Big} + \overline{Red})$
- ○ C. $Square \cdot \overline{(Big + Red)} + Big \cdot Red$
- ○ D. $Square \cdot (\overline{(Big + Red)} + Big \cdot Red)$

16. Select all Boolean expressions that are equivalent to:

$$\overline{\overline{PQ} + \overline{RS}}$$

- ○ A. $\overline{\overline{P} + \overline{Q} + \overline{R} + \overline{S}}$
- ○ B. $P + Q + R + S$
- ○ C. $\overline{PQ} \cdot \overline{RS}$
- ○ D. $PQRS$

Logic Design
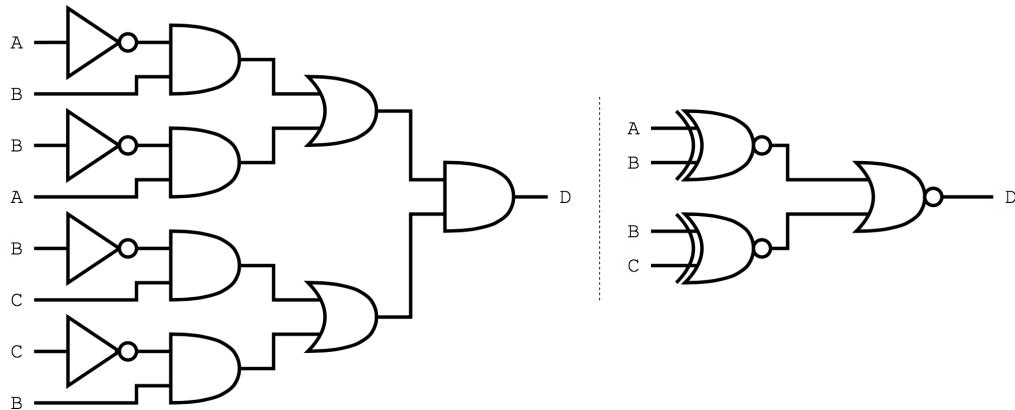
17. What is the Boolean algebra expression for a 3-bit XOR gate with inputs A, B, and C?
    - ○ A. $A \cdot \overline{B} \cdot C + \overline{A} \cdot B \cdot \overline{C} + \overline{A} \cdot \overline{B} \cdot C$
    - ○ B. $A \cdot \overline{B} \cdot \overline{C} + A \cdot B \cdot \overline{C} + \overline{A} \cdot \overline{B} \cdot \overline{C}$
    - ○ C. $A \cdot B \cdot \overline{C} + \overline{A} \cdot B \cdot \overline{C} + \overline{A} \cdot \overline{B} \cdot C$
    - ○ D. $A \cdot \overline{B} \cdot \overline{C} + \overline{A} \cdot B \cdot \overline{C} + \overline{A} \cdot \overline{B} \cdot C + A \cdot B \cdot C$
    - ○ E. None of the above

18. As we have learned, NAND gates can be used to create an equivalent circuit for any logical expression: What is the NAND gate equivalent of a 2-bit OR Gate with inputs A, B?
    - ○ A. A NAND B
    - ○ B. (A NAND A) NAND B
    - ○ C. A NAND (B NAND A)
    - ○ D. (A NAND A) NAND (B NAND B)

19. You wish to make a 3-bit "parity checker", which outputs a 1 if the total number of input 1's is odd. Which equation(s) do this? Select all that apply. (Note that $\oplus$ is the XOR operator).
    - ○ A. $A \oplus B \oplus C$
    - ○ B. $(A + B) \cdot (B + C) \cdot (A + C)$
    - ○ C. $ABC + A\overline{BC} + B\overline{AC} + C\overline{AB}$
    - ○ D. $(A + B + C) \cdot (\overline{A} + \overline{B} + \overline{C})$

20. What is the unsimplified Product of Sums boolean expression that represents the following truth table?

A	B	C	Out	A	B	C	Out
0	0	0	0	1	0	0	0
0	0	1	1	1	0	1	1
0	1	0	1	1	1	0	0
0	1	1	1	1	1	1	1

    - ○ A. $\overline{(A + B + C)} \cdot \overline{(\overline{A} + B + C)} \cdot \overline{(\overline{A} + \overline{B} + C)}$
    - ○ B. $(\overline{A} \cdot \overline{B} \cdot C) + (\overline{A} \cdot B \cdot \overline{C}) + (\overline{A} \cdot B \cdot C) + (A \cdot \overline{B} \cdot C) + (A \cdot B \cdot C)$
    - ○ C. $(\overline{A} + \overline{B} + \overline{C}) \cdot (A + \overline{B} + \overline{C}) \cdot (A + B + \overline{C})$
    - ○ D. $(A + B + C) \cdot (\overline{A} + B + C) \cdot (\overline{A} + \overline{B} + C)$
    - ○ E. $(A \cdot B \cdot C) + (\overline{A} \cdot B \cdot C) + (\overline{A} \cdot \overline{B} \cdot C)$

21. Your team needs to make a logic circuit that compares three 3-bit numbers, and outputs "1" if and only if two of those numbers are identical. Your teammate proposes making a truth table for each possible combination of inputs. How many rows would be in this truth table?
    - ○ A. 256 rows
    - ○ B. 9 rows
    - ○ C. 6 rows
    - ○ D. 27 rows
    - ○ E. 512 rows

22. What is the Sum of Products solution for the following truth table?

| A	B	C	Out
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1
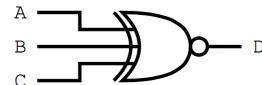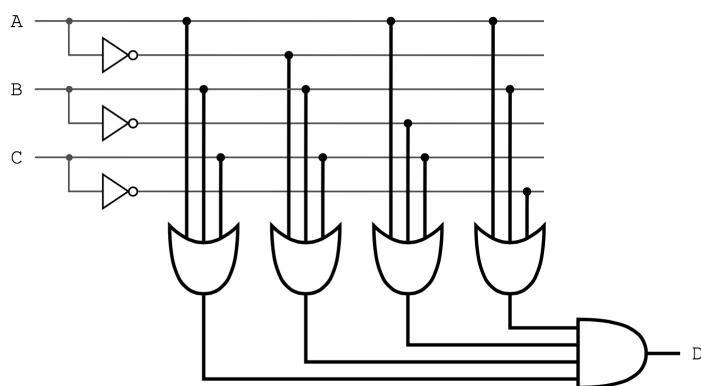
- A. $(\bar{A}+\bar{B}+\bar{C})\cdot(\bar{A}+B+\bar{C})\cdot(A+\bar{B}+C)\cdot(A+B+C)$
- B. $\bar{A}\cdot\bar{B}\cdot C+\bar{A}\cdot B\cdot C+A\cdot\bar{B}\cdot\bar{C}+A\cdot B\cdot\bar{C}$
- C. $A\cdot B\cdot\bar{C}+A\cdot\bar{B}\cdot\bar{C}+\bar{A}\cdot B\cdot C+\bar{A}\cdot\bar{B}\cdot C$
- D. $\bar{A}\cdot\bar{B}\cdot\bar{C}+\bar{A}\cdot B\cdot\bar{C}+A\cdot\bar{B}\cdot C+A\cdot B\cdot C$
- E. $(A+B+\bar{C})\cdot(A+\bar{B}+\bar{C})\cdot(\bar{A}+B+C)\cdot(\bar{A}+\bar{B}+C)$

23. T/F: These circuit diagrams are logically equivalent.
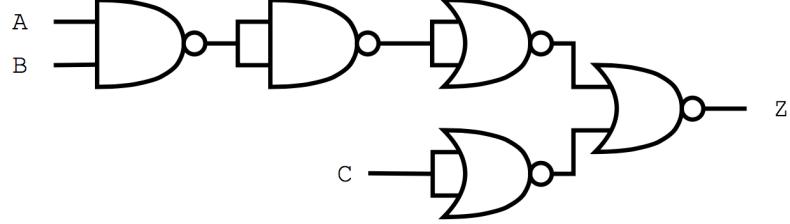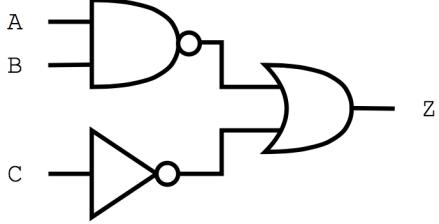
- A. False
- B. True

24. T/F: These circuit diagrams are logically equivalent.
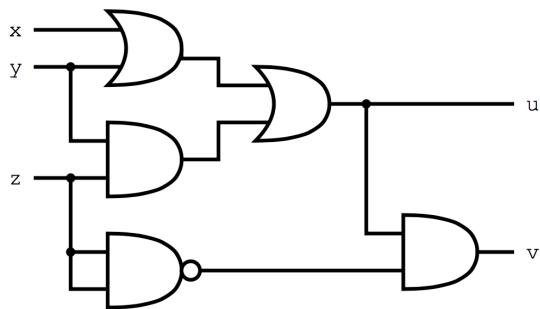
 A. True
 B. False

25. T/F: These circuit diagrams are logically equivalent.

 A. False
 B. True

The next two questions refer to the following logic circuit:

26. Given the schematic, which of the following expressions represents the output u?
 A. $x+y+z$
 B. $xz+y+z$
 C. $x+yz+z$
 D. $x+y+yz$

27. Given the schematic, which of the following expressions represents the output *v*?
    - ○ A. None of the other answers
    - ○ B. $(x+y) \cdot yz$
    - ○ C. $(x+y)+yz$
    - ○ D. $xyz+xz$
    - ○ E. $x+y+\overline{yz}$
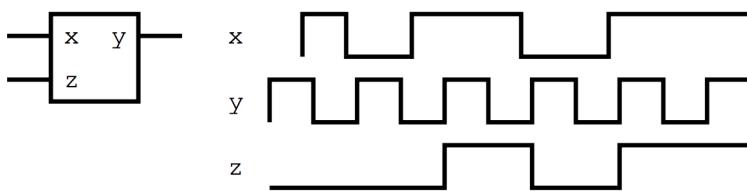
Sequential Logic

28. In an active high S-R latch, what happens if both S and R are high?
    - ○ A. Q holds its value.
    - ○ B. Q is 'set' to 1.
    - ○ C. Q is 'reset' to 0.
    - ○ D. This is an invalid combination.

29. What device does this timing diagram represent:

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

Arithmetic and Logic Operations

30. What is the result of a bit-wise AND of the decimal numbers 11 and 7?
    - ○ A. 3
    - ○ B. 2
    - ○ C. 15
    - ○ D. 7

31. Assume a signed integer x=0x4B. What are the results of x $<<$ 4 (shift left by 4) for logical shift and x $>>$ 4 (shift right by 4) for arithmetic shift?
    - ○ A. 0xBF and 0xF4
    - ○ B. 0xB0 and 0x00
    - ○ C. 0x00 and 0x00
    - ○ D. 0x40 and 0x04
    - ○ E. 0xB0 and 0x04 .

32. The result of the bit-wise AND operation between 0xCAFE and 0xBABE is:
    - ○ A. 1011111011101111_2
    - ○ B. 1011101010111001_2
    - ○ C. 1000101010111110_2
    - ○ D. 1111111011101101_2
    - ○ E. 1001101011110010_2

33. Which of these 8-bit two's complement computations have overflow but no carry-out? Assume answers are expressed in binary. Select all that apply.
    - ○ A. 1111 1111 + 0000 0001
    - ○ B. 1000 0000 + 1000 0001
    - ○ C. 0111 1111 + 0000 0001
   - ○ D. 0111 1111 + 0111 1111
    - ○ E. 1000 0000 + 0000 0001
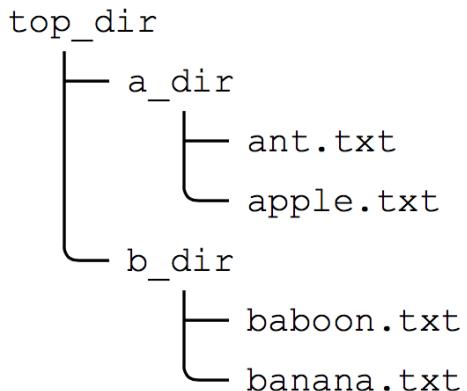
34. What is the result of a bit-wise XOR performed on the following binary numbers?

$$0\ 1\ 1\ 0\ 0\ 1$$
$$\oplus\quad 1\ 1\ 0\ 1\ 1\ 1$$

    - ○ A. 010001_2
    - ○ B. 101110_2
    - ○ C. 010000_2
    - ○ D. 111111_2

Command Line and Git

The next two questions refer to the following directory structure:

```
top_dir
├── a_dir
│   ├── ant.txt
│   └── apple.txt
└── b_dir
    ├── baboon.txt
    └── banana.txt
```

35. Given that the command `pwd` prints "/top_dir/b_dir", what will the command `ls` print after execution of the following commands?
    ```
    cp ../a_dir/ant.txt .
    ```

    - ○ A. baboon.txt banana.txt
    - ○ B. ant.txt baboon.txt banana.txt
    - ○ C. ant.txt apple.txt
    - ○ D. ant.txt apple.txt baboon.txt banana.txt

36. Given that the command `pwd` prints "/top_dir/b_dir", after you enter the following two commands, what will the command `ls` print?
    ```
    cd ..
    mkdir c_dir
    ```

    - ○ A. a_dir b_dir c_dir
    - ○ B. baboon.txt banana.txt
    - ○ C. ant.txt baboon.txt banana.txt c_dir
    - ○ D. baboon.txt banana.txt c_dir

37. In a bash terminal, you enter the command `mkdir test` followed by `cd test` What does it do?
    - ○ A. The OS creates a new directory, and the terminal's current working directory is now that directory
    - ○ B. git checks the repo for the files "mkdir" and "cd"
    - ○ C. The OS creates a new directory for the compact disc drive
    - ○ D. git creates a new repo named "test" and moves it to your computer

38. Which command is used in Linux to rename a file?
    - ○ A. cat
    - ○ B. mv
    - ○ C. ls -l
    - ○ D. rm

39. Alice and Bob are sharing a repo. They both pull the repo on Monday. On Tuesday, Bob makes some changes, commits them, and pushes them. On Wednesday, Alice makes some changes, commits them, and attempts to push them. Does a merge conflict occur?
    - ○ A. Yes
    - ○ B. No
    - ○ C. Maybe, depending on the changes Bob made.
    - ○ D. Maybe, depending on the changes Alice made.

40. Which git command is used to check paths that have differences between the working tree and the index file?
    - ○ A. git status
    - ○ B. git commit
    - ○ C. git add
    - ○ D. git log