

# Midterm 1 review

CS51 – Spring 2026

# Midterm logistics

1 double-side page of notes, hand-written

# Topics

History of CS

Ethics

Boolean algebra

- Operators: AND, OR, NOT, XOR
- Evaluating expressions
- Laws: distributive law, De Morgan's
- DNF – minterm expansion
- CNF – maxterm expansion
- K-Maps

# Topics continued

## Number representation

- Converting between bases
- Binary: unsigned, sign/magnitude, twos complement, fixed vs. variable length
- Addition in other bases
- Shifting: left vs. right, arithmetic vs. logical
- Overflow

# Topics continued

## Bitwise operators

- `&`, `|`, `^`, `~`
- masking
- bitwise operations in Python
  - `bit_length()`

## Representing other information in binary

# Topics continue

## Circuits

- Gates: AND, OR, NOT, XOR, NAND, XNOR
- Circuits from truth tables
- Half-adder/adder, ripple-carry adder
- Decoder
- Multiplexer
- Barrel shifter

# Topics continued

## Memory

- Different types: registers, RAM, hard-drive
- Units of memory: bit, nibble, byte...
- Memory implementation
- SR-latch

# Topics continued

## CS51 machine

- “Hardware” setup, i.e., registers
- Assembly
  - arithmetic operations
  - branch operations
  - loa/sto (particularly for I/O)

Will not be asked to write any assembly code

Only material from 2/17 on this checkpoint (i.e., no functions)

# Practice Problem 1

- Assuming unsigned numbers, fill in the rest of the missing entries in the table for representations in other bases.

Binary	Decimal	Hex
100101		
	910	
		1AB

# Answer Problem 1

Binary	Decimal	Hex
100101	37	25
1110001110	910	38E
000110101011	427	1AB

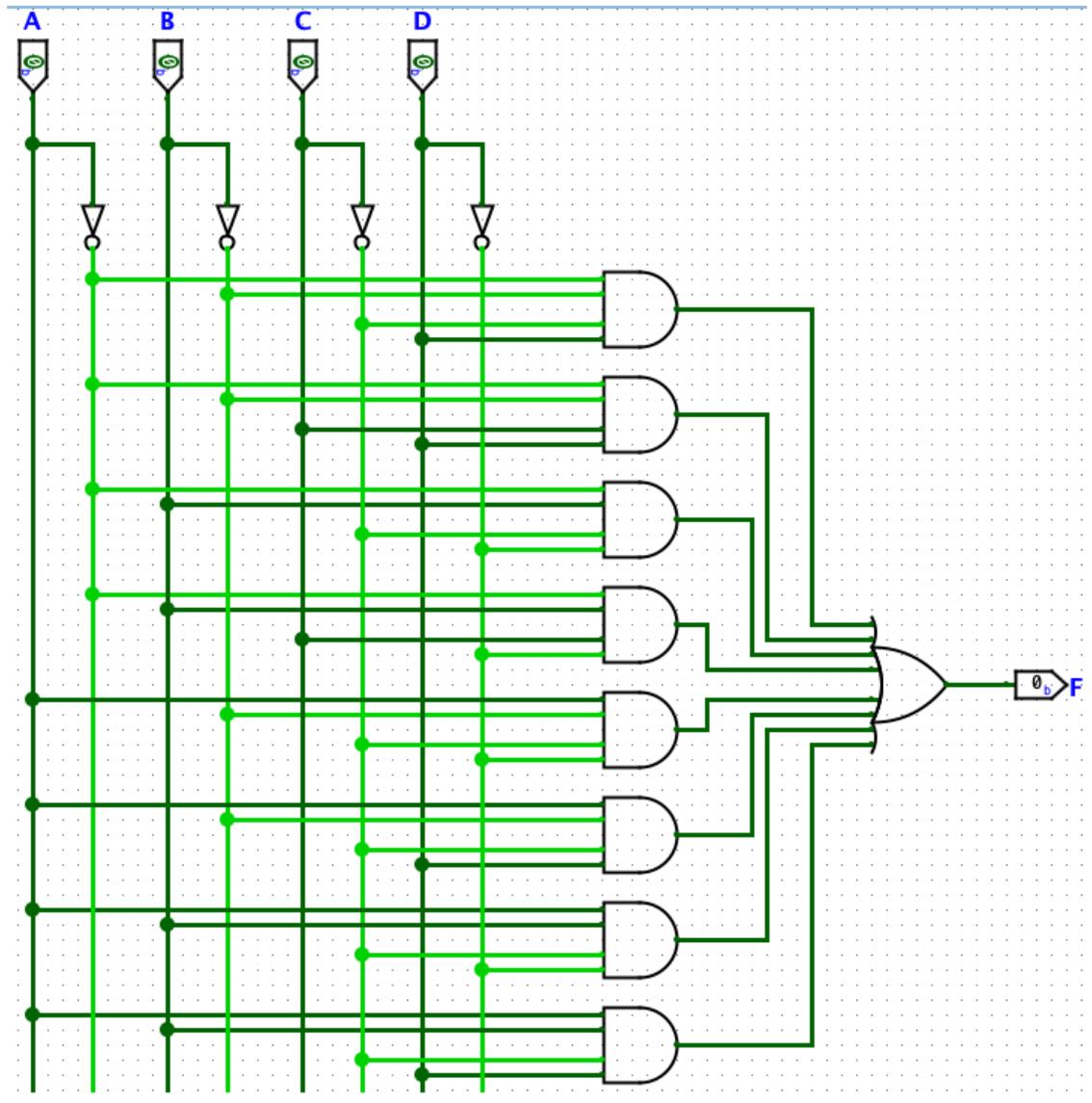
# Practice Problem 2

- i) Given this 4-variable Boolean function, calculate its DNF and build the circuit that corresponds to this minterm expansion. ii) use a K-map to simplify it and build the corresponding circuit.

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

## Answer 2

- i) Given this 4-variable Boolean function, calculate its DNF and build the circuit that corresponds to this minterm expansion DNF:
- $m_1 \vee m_3 \vee m_4 \vee m_6 \vee m_8 \vee m_9 \vee m_{12} \vee m_{13}$



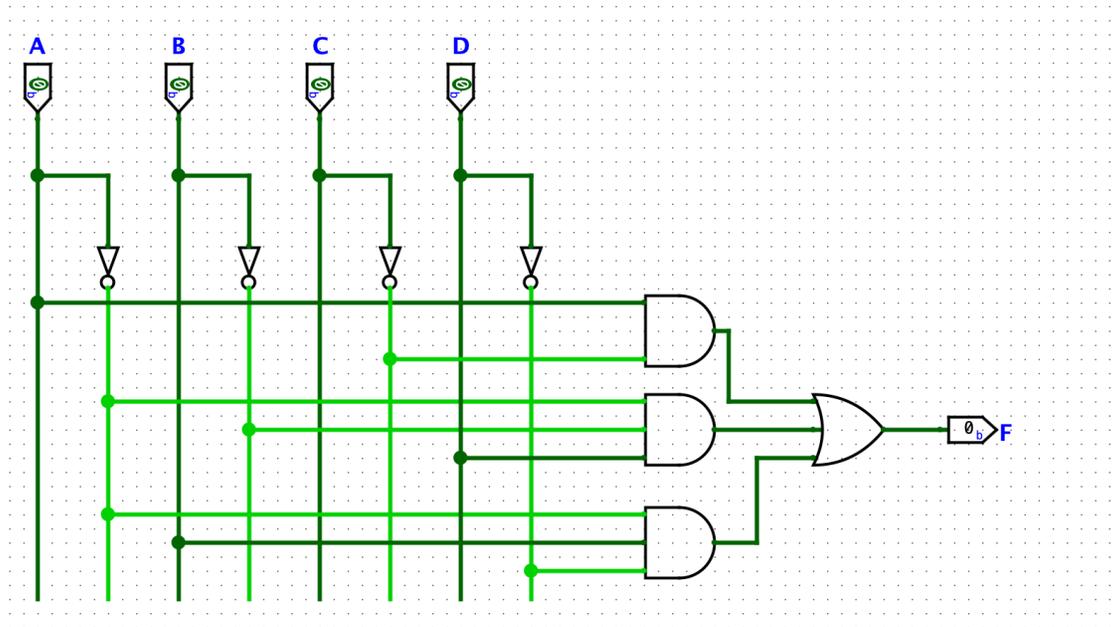
# Answer 2

- ii) use a K-map to simplify it and build the corresponding circuit.

		<i>CD</i>			
		00	01	11	10
<i>AB</i>	00	0	1	1	0
	01	1	0	0	1
	11	1	1	0	0
	10	1	1	0	0

red:  $A \wedge \neg C$  green:  $\neg A \wedge \neg B \wedge D$  yellow:  $\neg A \wedge B \wedge \neg D$

Simplified:  $(A \wedge \neg C) \vee (\neg A \wedge \neg B \wedge D) \vee (\neg A \wedge B \wedge \neg D)$



# Practice Problem 3

- What would the results of the following bitwise masks be in decimal?
- $\sim 8$
- $9 \& 3$
- $-2 | 3$
- $7 \wedge 9$

## Answer 3

- What would the results of the following bitwise masks be in decimal?
- $\sim 8 = -9$ . Remember,  $\sim x = -(x+1)$
- $9 \& 3 = 1$ 
  - $01001 \& 00011 = 0001$
- $-2 | 3 = -1$ 
  - $110 | 001 = 111$
- $7 \wedge 9 = 14$ 
  - $00111 \wedge 01001 = 01110$

# Practice Problem 4

- Assuming  $x$  is a positive number, what would the following function do?

```
def mystery(x):  
    return x & (x - 1)
```

## Practice Problem 4

- It resets (sets to 0) the least significant set bit (the right most bit that is 1) in  $x$ .