Midterm 1 review

CS51 – Fall 2026

Midterm logistics

You can bring 1 double-side page of notes, hand-written. OK to use stylus on your tablet to write notes but CANNOT just copy paste slides and print them.

Topics

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 different bases
- Binary: unsigned, sign/magnitude, twos complement, sign extension
- Addition in non-decimal bases
- Shifting: left vs. right, arithmetic vs. logical
- Overflow

Topics continued

Bitwise operators

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

Topics continued

Circuits

- Gates: AND, OR, NOT, XOR, NAND, NOR
- Creating circuits from truth tables
- Half-adder, full adder, ripple-carry adder
- Decoder
- Multiplexer
- Barrel shifter

Topics continued

Memory

- Different types: registers, main memory (RAM and ROM), external memory (hard-drive)
- Units of memory: bit, nibble, byte...
- Addressing memory cells by row and column
- SR-latch

Topics continued

CS51 machine

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

Will not be asked to write any assembly code

Only material from 9/24 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

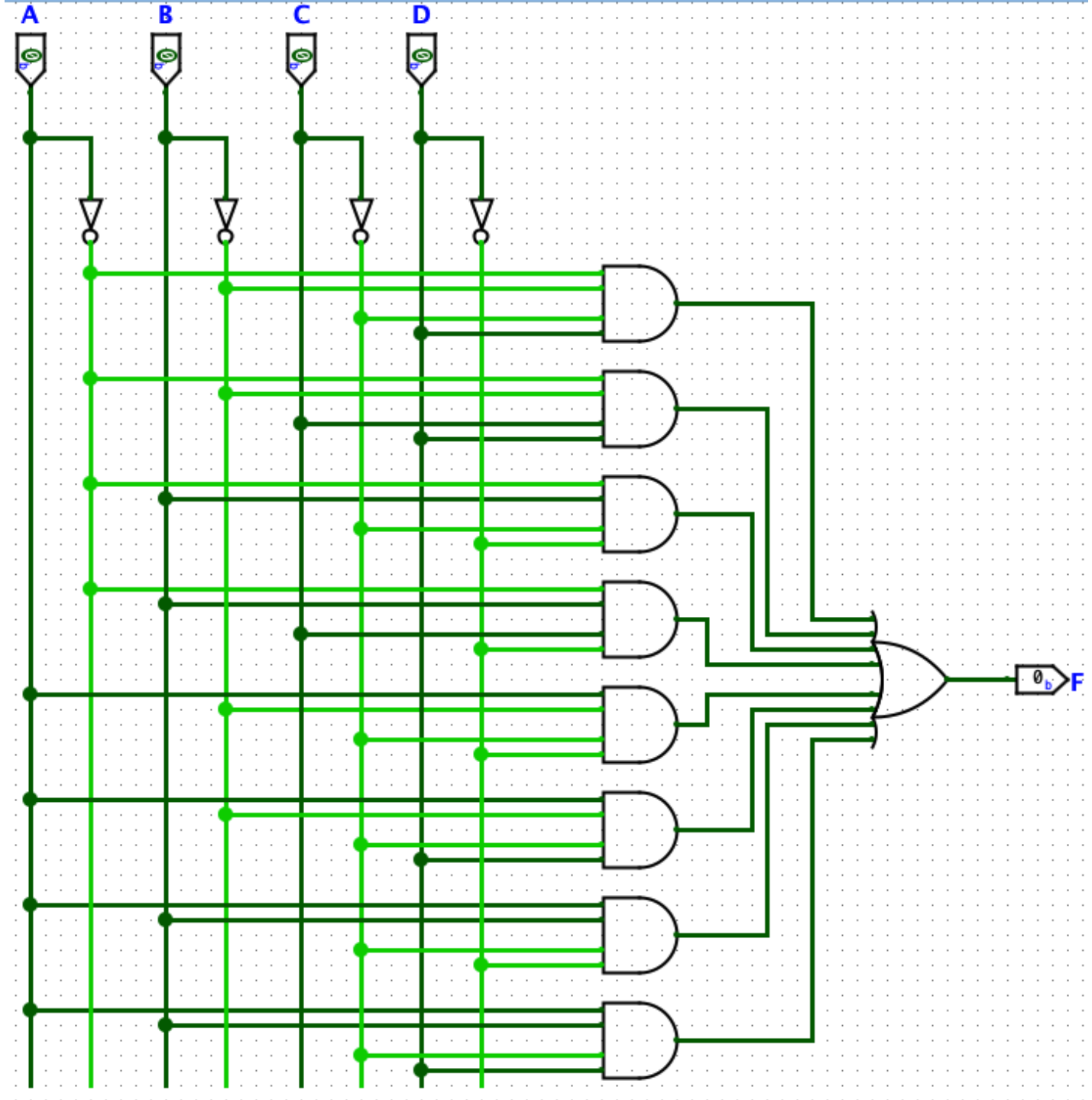
Practice Problem 2

- i) Given this 4-variable Boolean function, calculate is 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 is DNF and build the circuit that corresponds to this minterm expansion DNF:
- m1 v m3 v m4 v m6 v m8 v m9 v m12 v m13



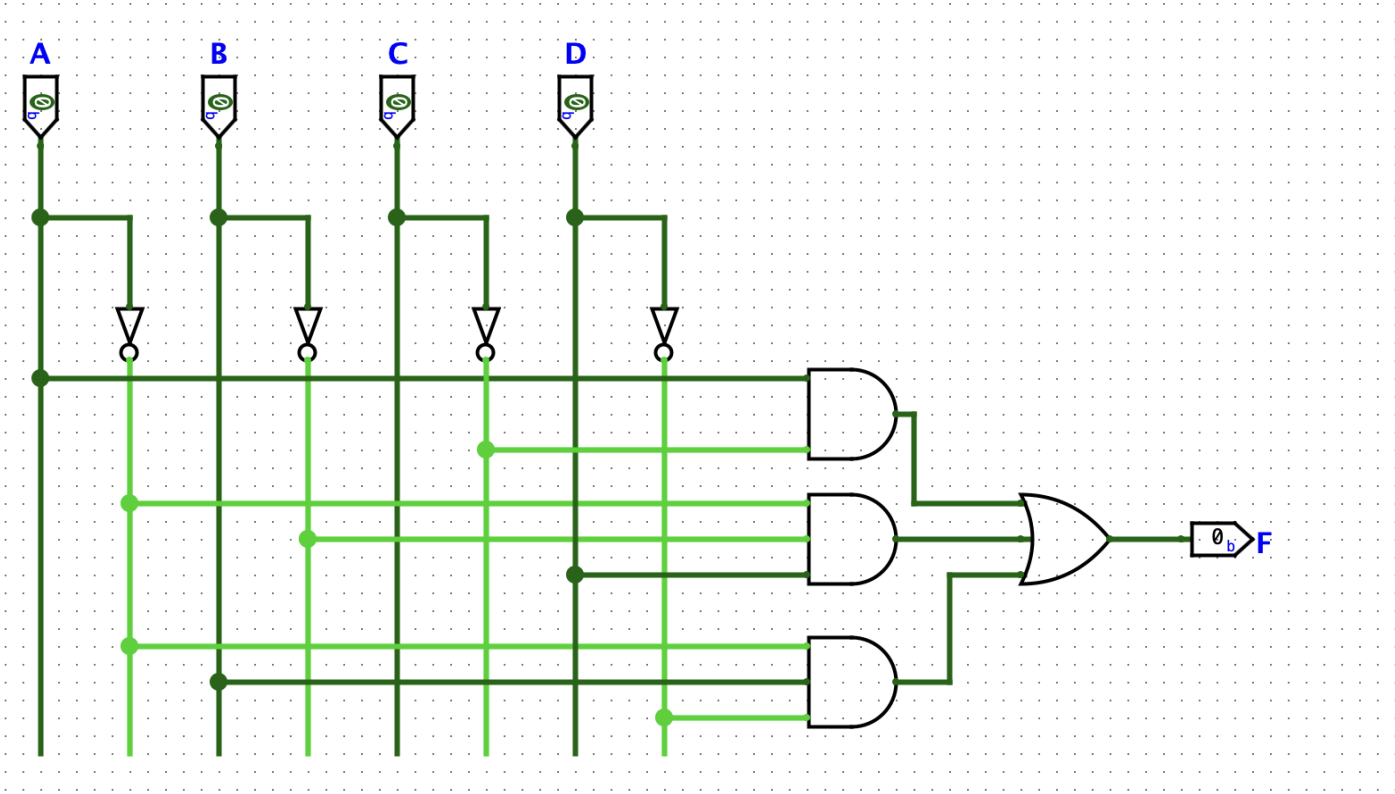
Answer 2

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

AB \ CD	00	01	11	10
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 operations be in decimal?
  - ~8
  - 9&3
  - -2|3
  - 7^9

Answer 3

- What would the results of the following bitwise operations be in decimal?
  - ~8 = -9. Remember, ~x=-(x+1)
  - 9&3 = 1
    - 01001 & 00011 = 0001
  - -2|3 =-1
    - 110|011=111
  - 7^9=14
    - 00111^01001= 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.