Boolean Logic

ECE 320 Electronics I

Jake Glower - Lecture #19

Please visit Bison Academy for corresponding lecture notes, homework sets, and solutions

Boolean Logic

- Black and White world ("for us or against us")
- Either true (logic 1) or false (logic 0)
- Other forms of logic exist (ex. fuzzy logic)

Sith Lords: https://wallpaperplay.com/board/sith-lord-wallpapers

AND: Y is true of A and B are both true. It's false otherwise.

OR: Y is true if either A or B is true.

NOT: Y = NOT A means that whatever A is, Y is the opposite.

DeMorgan's Theorem:

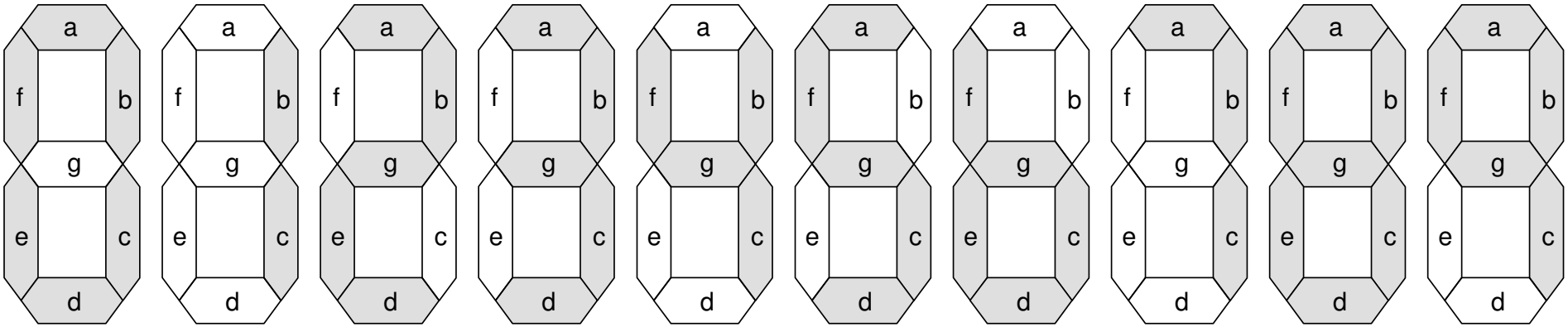
$$\overline{AB} = \overline{A} + \overline{B}$$

$$\overline{A + B} = \overline{A} \cdot \overline{B}$$

A	B	Y = AB	Y = (AB)'	Y = A+B	Y = (A+B)'	A'
		AND	NAND	OR	NOR	NOT
0	0	0	1	0	1	1
0	1	0	1	1	0	1
1	0	0	1	1	0	0
1	1	1	0	1	0	0

Implementing Logic Using NAND Gates

- Input = 4 digital signals (ABCD)
- Output: 0 = light off, 1 = light on
- Relationship: LED (a) for a 7-segment display



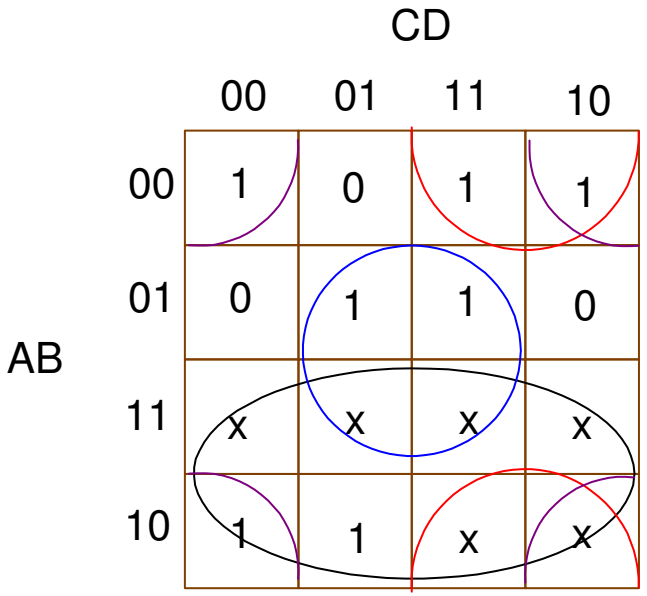
Karnough Maps:

Ya(ABCD)

AB \ CD	00	01	11	10
00	1	0	1	1
01	0	1	1	0
11	x	x	x	x
10	1	1	x	x

Circle the ones to generate Ya:

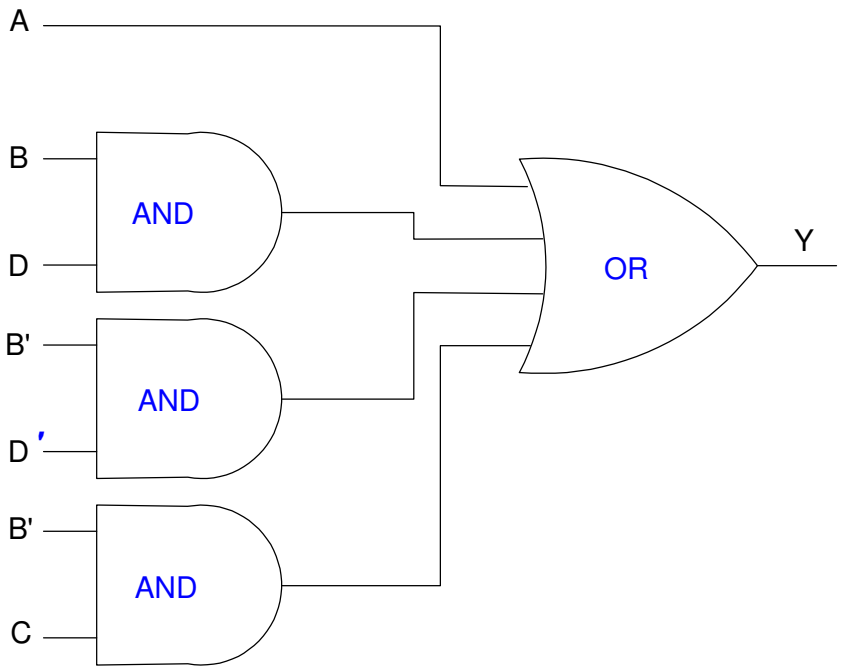
$$Y = A + BD + \overline{B}\,\overline{D} + \overline{B}C$$

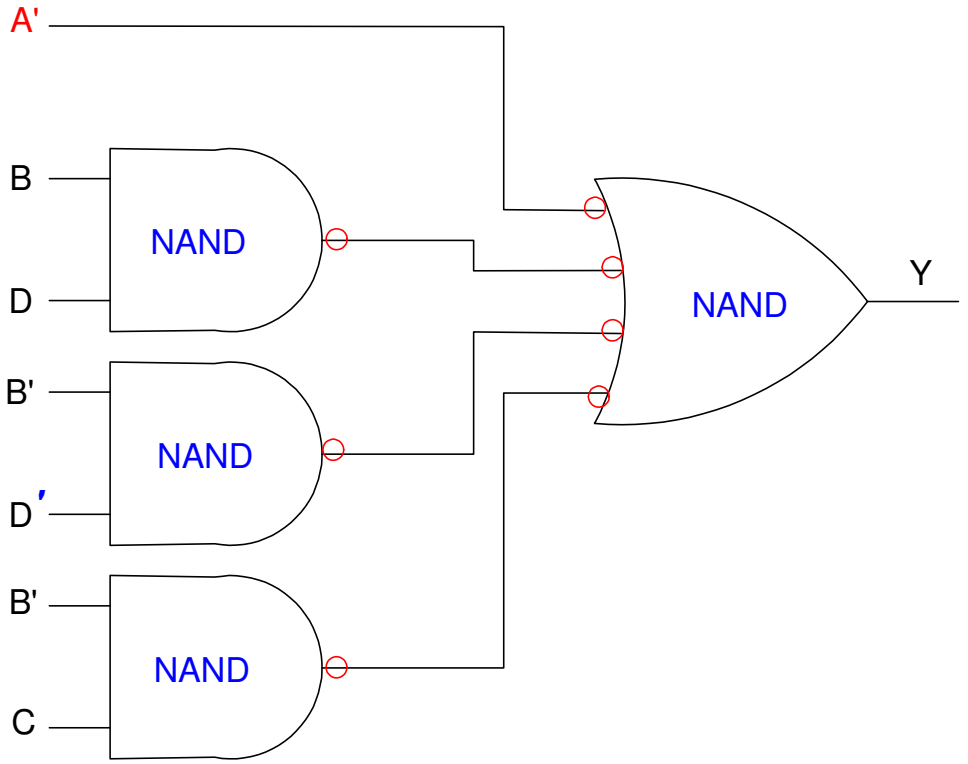


Implement this using AND and OR gates

$$Y = A + BD + \overline{B}\,\overline{D} + \overline{B}C$$

To convert to NAND gates, add in a double-negative





Handout:

Implement the following logic using NAND gates

Y		CD			
		00	01	11	10
AB	00	1	0	1	1
	01	0	1	0	1
	11	x	x	x	x
	10	1	0	x	x

Implementation using NOR Gates

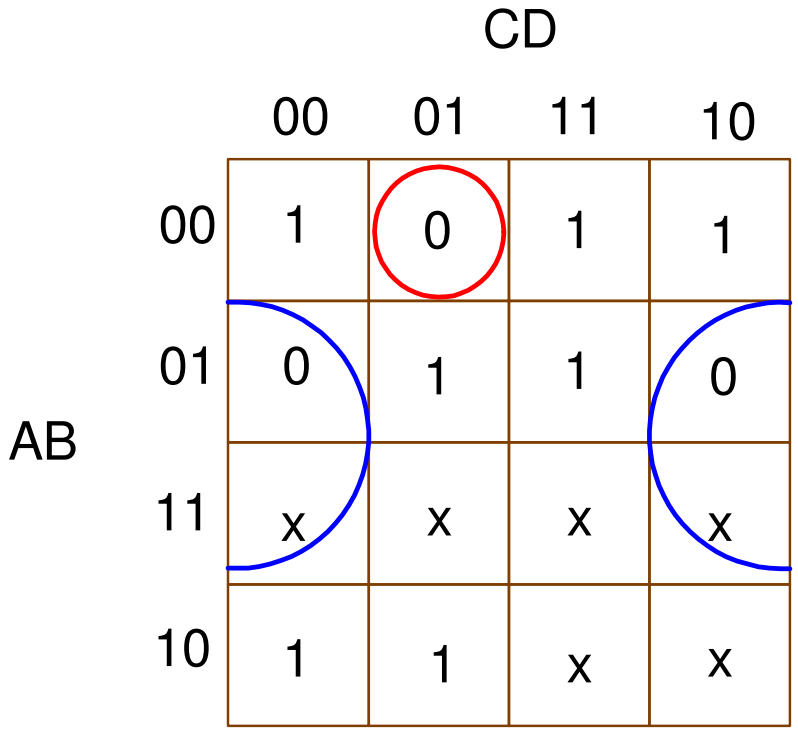
Circle the zeros

$$\overline{Y} = \overline{A}\overline{B}\overline{C}D + B\overline{D}$$

Use DeMorgan's theorem

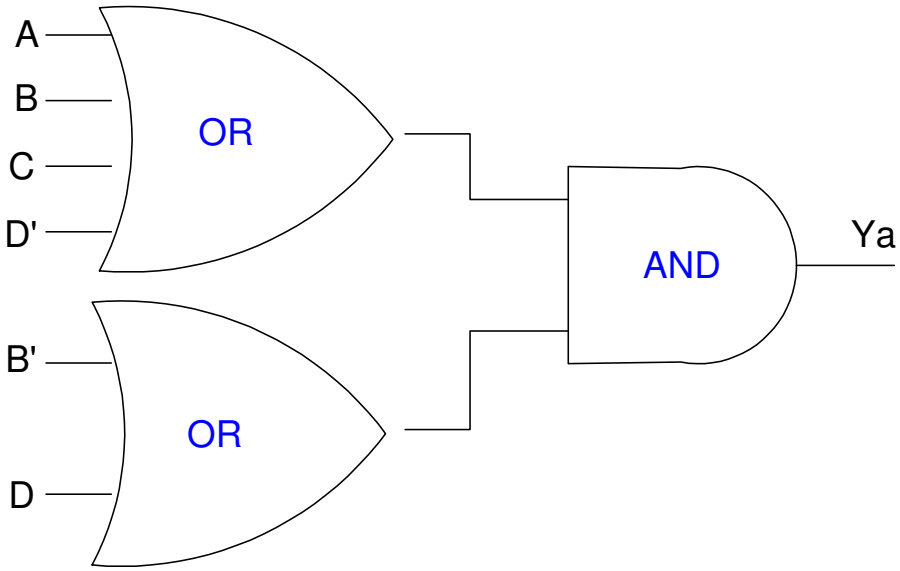
$$Y = \overline{\overline{A}\overline{B}\overline{C}D + B\overline{D}}$$

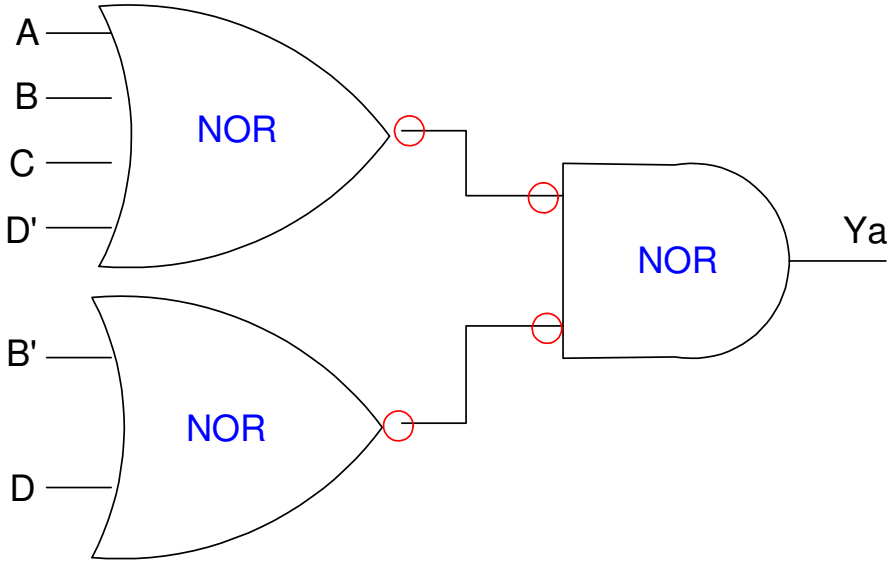
$$Y = (A + B + C + \overline{D})(\overline{B} + D)$$



Implement using OR and AND gates

- $Y = (A + B + C + \overline{D})(\overline{B} + D)$
- Add in a double-negative to turn these into NOR gates





Handout

Implement the following logic using NOR gates

Y		CD			
		00	01	11	10
AB	00	1	0	1	1
	01	0	1	0	1
	11	x	x	x	x
	10	1	0	x	x

Summary:

- You can implement any logic using NAND or NOR gates.
- The only difference is if you prefer circling the ones (NAND) or zeros (NOR).

Next lectures

- How to build NAND and NOR gates at the transistor level