Lecture 20

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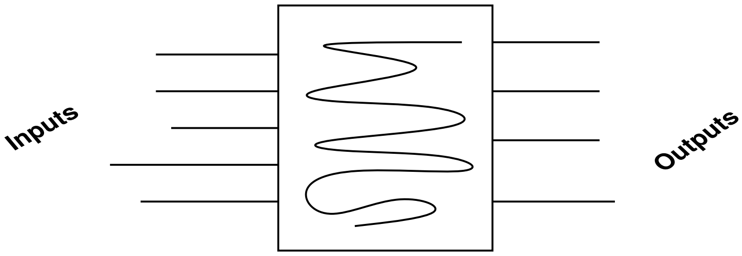
April 18, 1996

Sequential circuits

It's not enough to know how to add, we want to remember the answer! (also, we need to know how to count...)

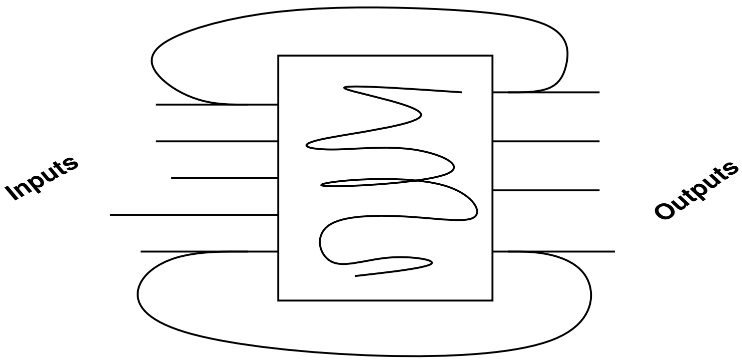
Combinational circuits ex: add, decode



characterized by no loops

output well-defined function of input

Sequential circuits ex: flip-flop



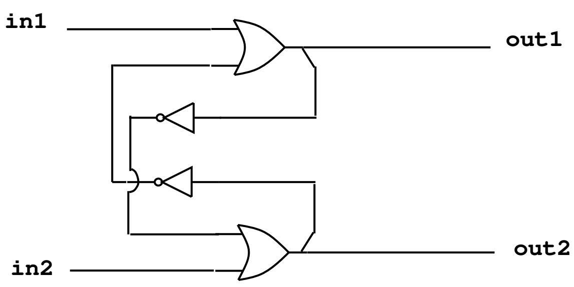
characterized by loops (FEEDBACK)

output depends on past inputs as well as current inputs

"past" introduces TIME, memory

Storing a bit

Simple sequential circuit
Capable of ``storing`` a bit



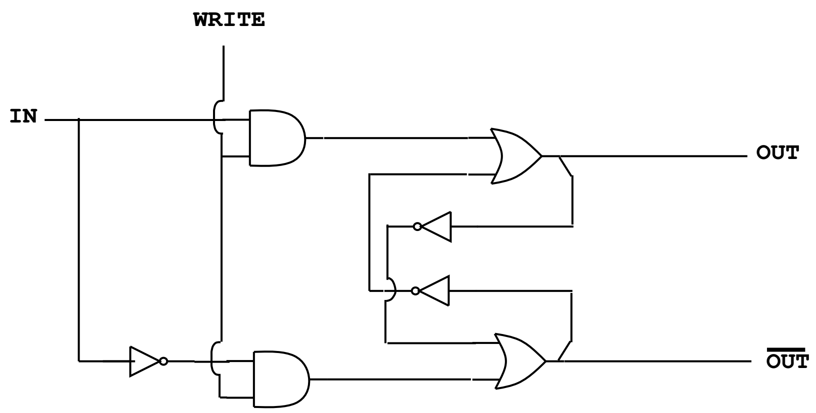
in1	in2	out1	out2
0	0	NOT(previous out2)	NOT(previous out1)
0	1	0	1
1	0	1	0
1	1	1	1

with out1 = NOT(out2)

in1	in2	out1	out2
0	0	previous out1	previous out2
0	1	0	1
1	0	1	0
1	1	don't	allow

Flip-Flop

How control storage circuit?

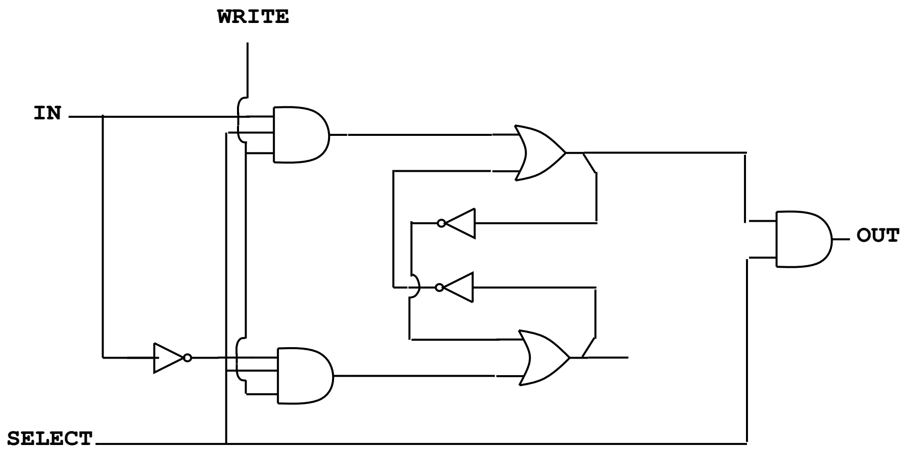


called FLIP-FLOP

if WRITE =1, OUT <- IN
otherwise, OUT holds at last value
REMEMBERS

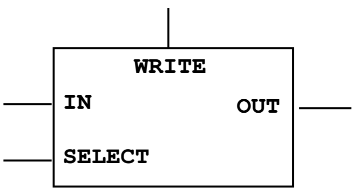
Memory -- 1 bit

Want to be able to write new value or
read stored value of a selected flip-flop
addressing
add "SELECT" input



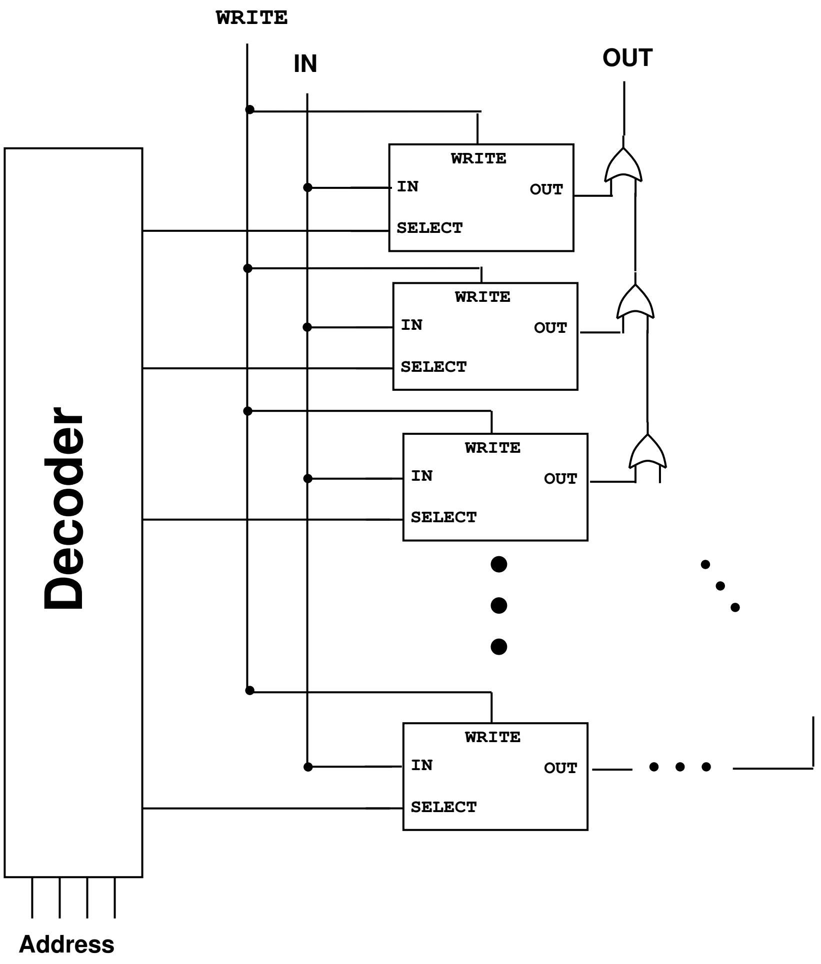
if SELECT=0, internally hold value; OUT = 0
if SELECT=1 and WRITE=0, OUT=old value
if SELECT=1 and WRITE=1, OUT <- IN and
"store" value of IN

symbol



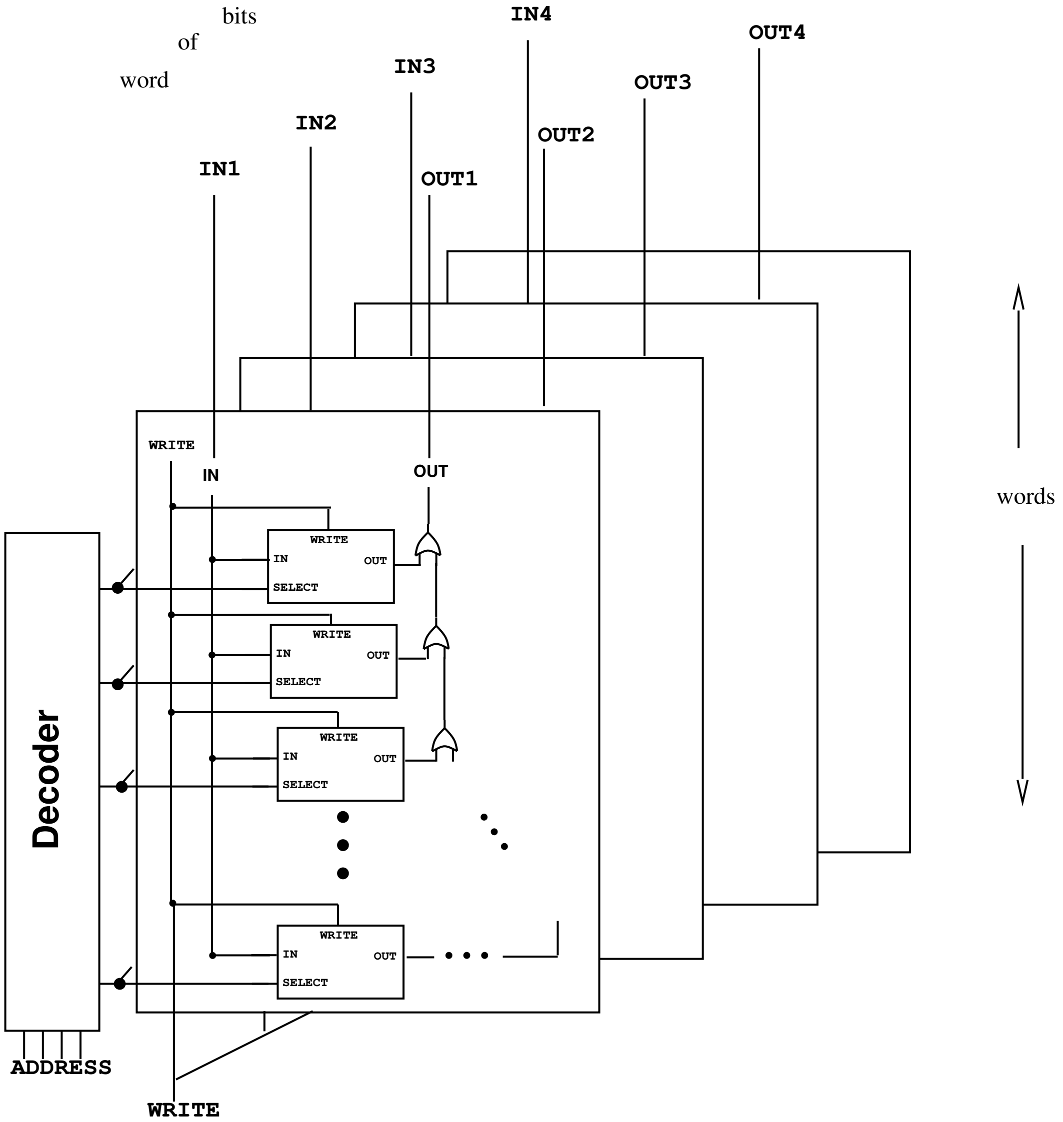
Memory array (bits)

Connect SELECT lines to decoder
address 1010 into decoder, SELECT
puts <u>value</u> of flip-flop 1010 on OUT



Memory (words)

"Bit slice"
build circuit for first bit in every word
copy circuit 16 times for 16-bit word



Long and thin: actual memories split address into "row" and "column"