Imperial College London

BIOE40002 – Computer Fundamentals and Programming 1

Part I – Digital Logics, Lab 6

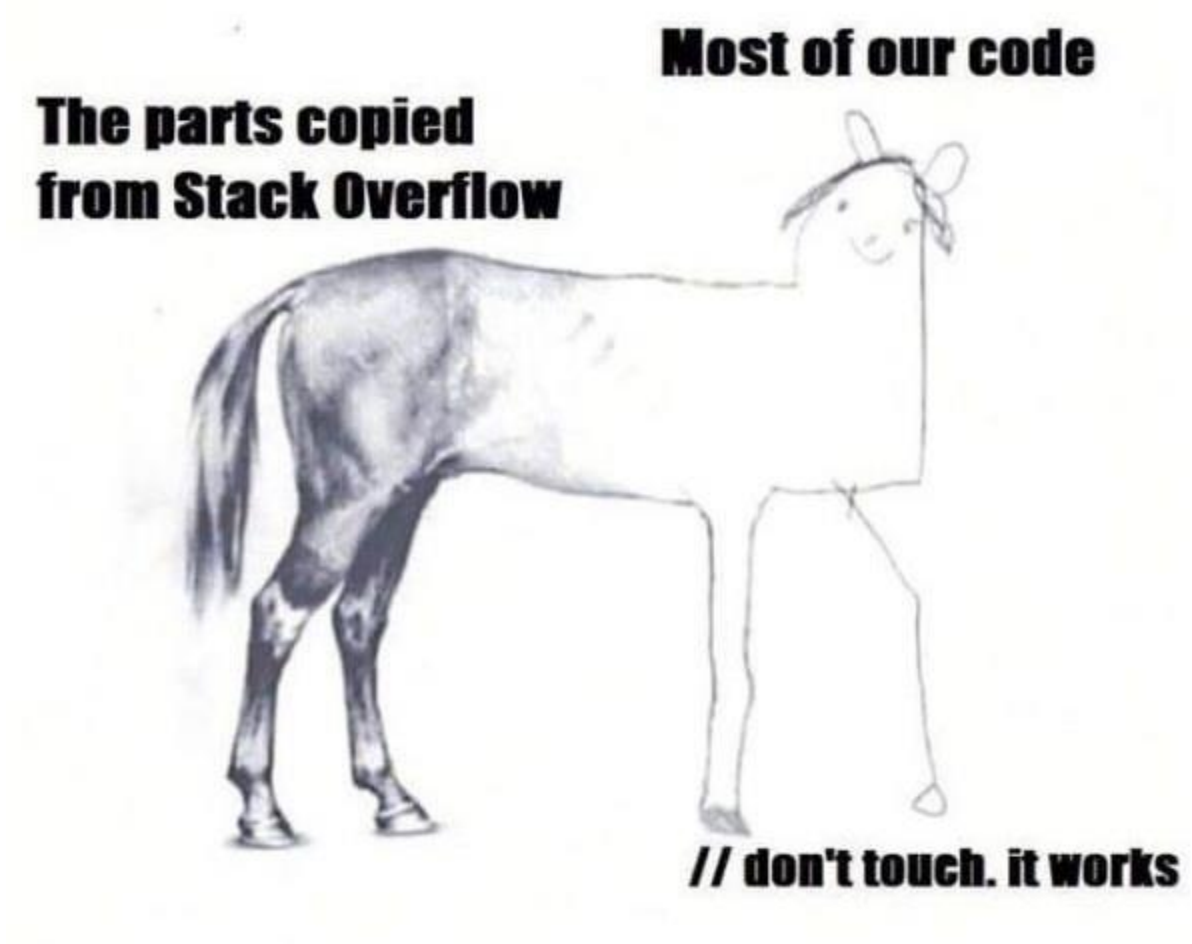
Binghuan Webster Li | *Department of Bioengineering*

binghuan.li19@imperial.ac.uk

February 24, 2022

Meme of the day…

Imperial College London

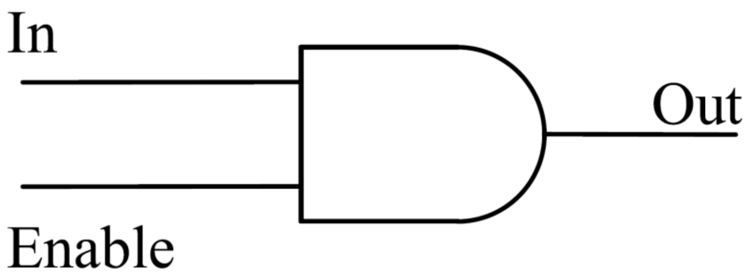


Today's Schedule

Imperial College London

- Recap (~ 10 mins)
  - Selectors and multiplexers
  - Arithmetic-logic units
- Lab exercises 12 and 13
- Quick summary

AND gates as selectors

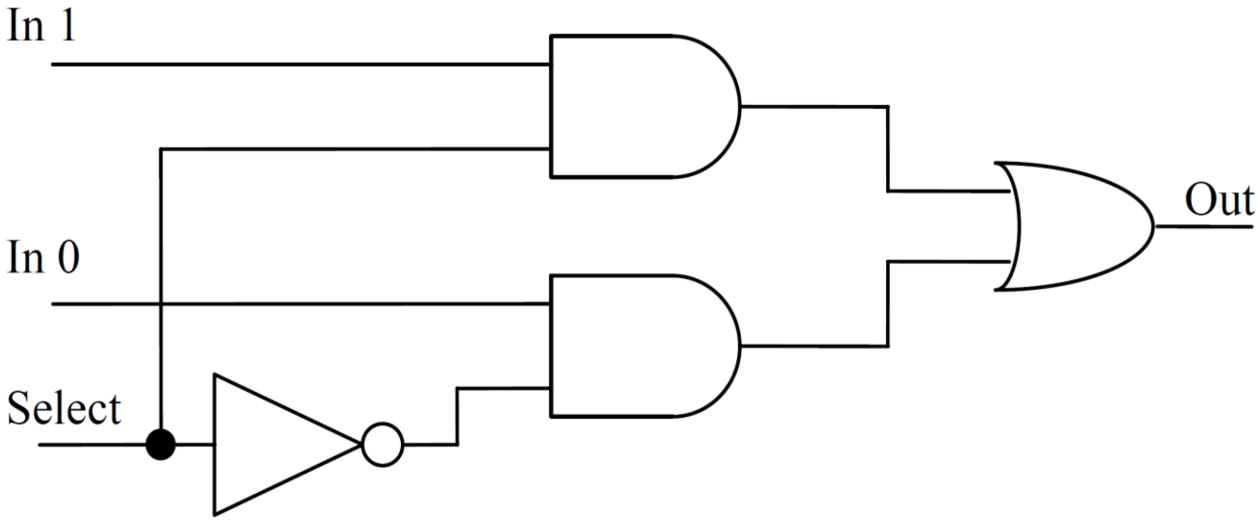


Enable	*In*	*Out*
0	0	**0**
0	1	**0**
1	0	**0**
1	1	**1**

- When *Enable* is set to 1, output follows input
- When *Enable* is set to 0, output would remain 0 regardless of the value of input
- Selector

2 × 1 multiplexer

Imperial College London

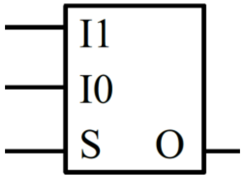


In 0	*In 1*	*Select*	*Out*
0	0	0	**0**
0	1	0	**0**
1	0	0	**1**
1	1	0	**1**
0	0	1	**0**
0	1	1	**1**
1	0	1	**0**
1	1	1	**1**

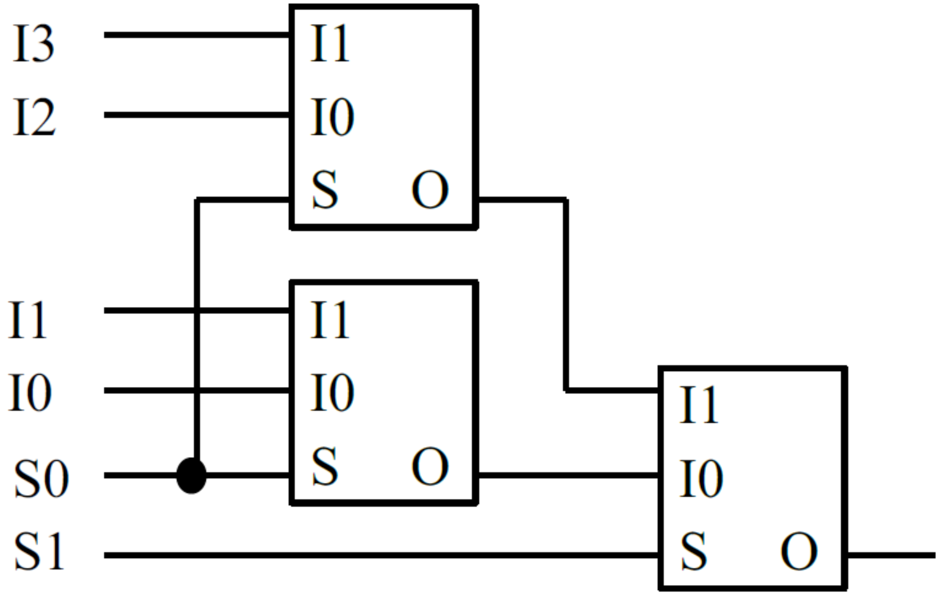
In 0 (rows with Select = 0)

In 1 (rows with Select = 1)

- When *Select* is set to 1, output follows input channel 1 (*In1*)
- When *Select* is set to 0, output follows input channel 0 (*In0*)
- 2 × 1 multiplexer



4 × 1 multiplexer

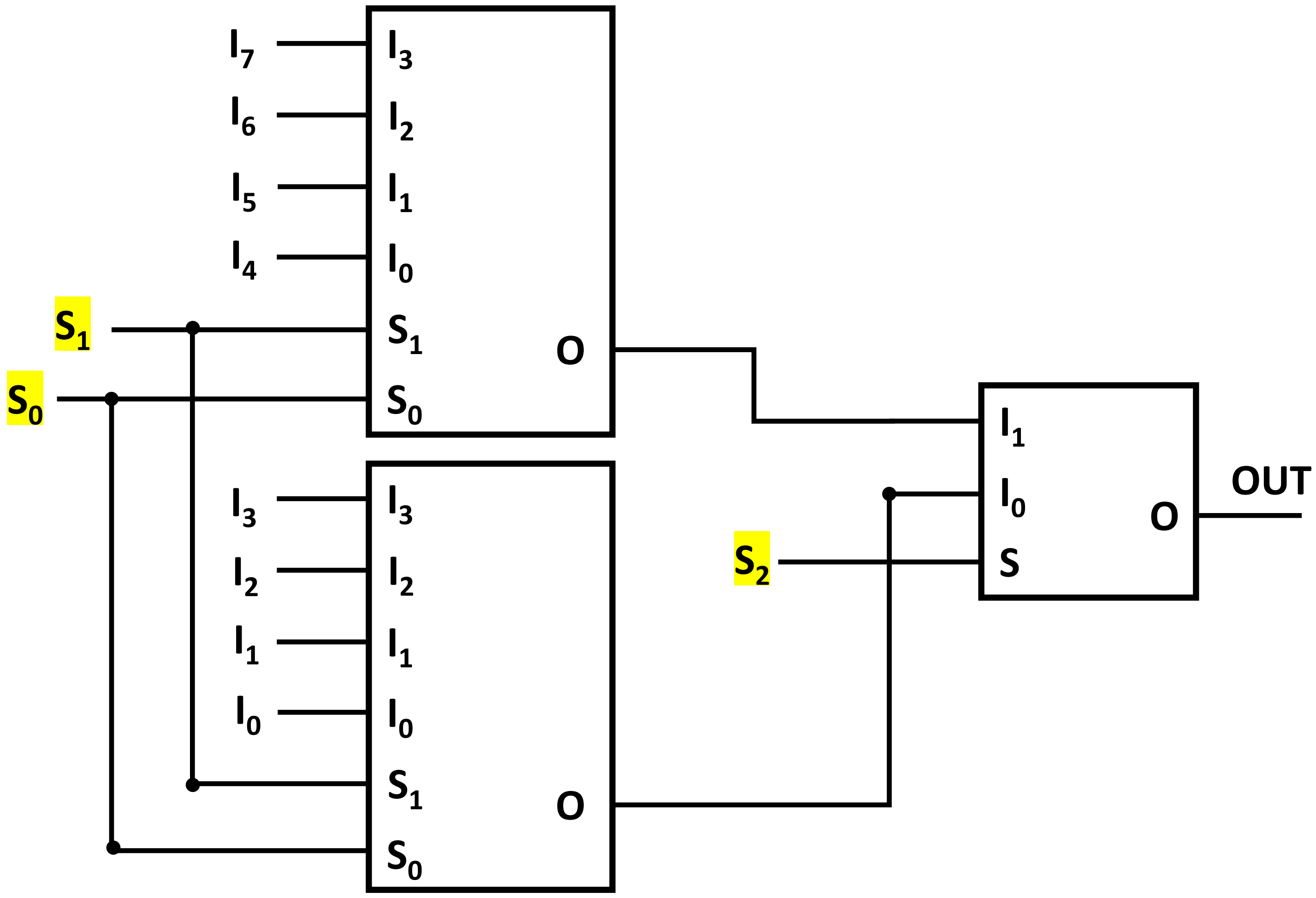


- 2 selector terminals – *S0*, *S1*
- Select the signal from *I0*, *I1*, *I2*, *I3*

- E.g., *S0=1*, *S1=1*; *O=I3*

It is your turn to design a 8 × 1 multiplexer with two 4 × 1 multiplexers and one 2 × 1 multiplexer !

Task 12 – Design an 8x1 multiplexer



- Selection terminal: S_0-S_2
- Input signal: I_0-I_7

4-operation arithmetic-logic units

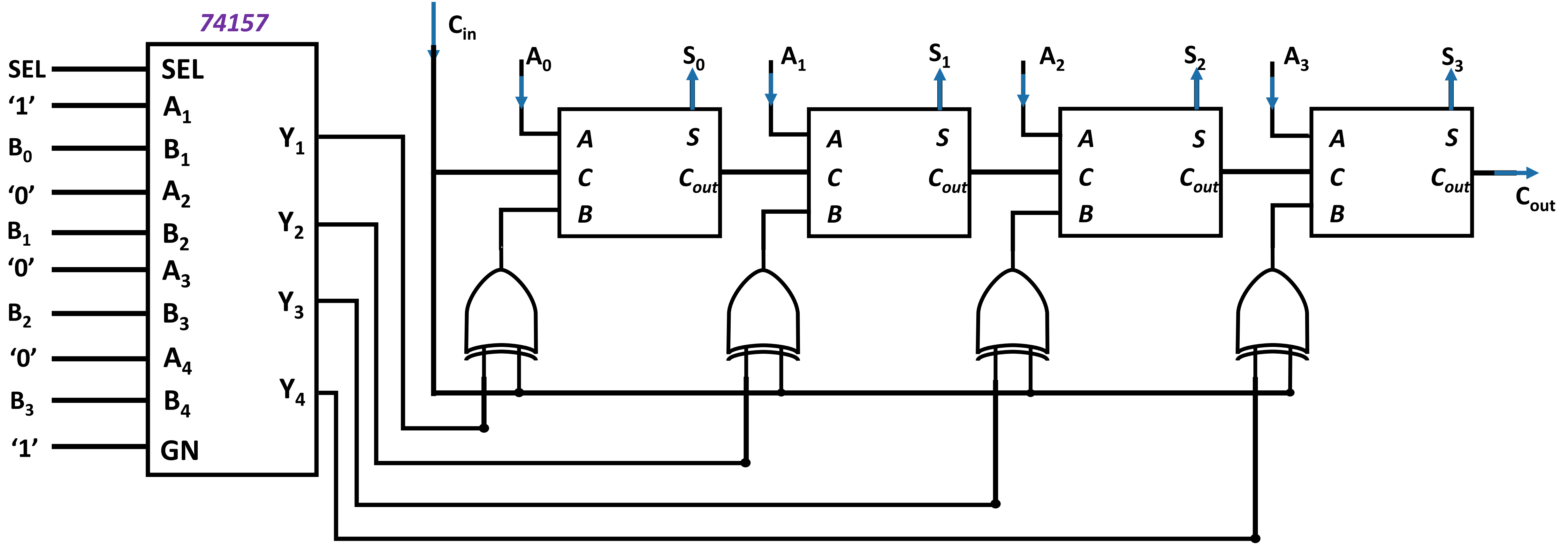
Imperial College London

Instruction 0 *Set_B=1*	**Instruction 1** *Subtract*	**Operation**
0	0	ADD
0	1	SUB
1	0	INC
1	1	DEC

- ADD = $A+B$
- SUB = $A+(-B)$
- INC = $A+1$ → set $B = 1$
- DEC = $A+(-1)$ → set $B = -1$

- *Q:* how to design such a 4-operation ALU with **a 4-bit addition/subtraction machine** and **a multiplexer**?
- *A:* think about how we set the input *B*!

4-operation arithmetic-logic units



- $A_4A_3A_2A_1$ = 0001 → instruction 0 (Set_B=1) → INC, DEC
- $B_4B_3B_2B_1$ = 4-bit inputs → ADD, SUB
- C_{in} → instruction 1 (subtraction)

	SEL = 0	SEL=1
C_{in} =0	INC	ADD
C_{in} =1	DEC	SUB

Imperial College London

Questions?

That's it for now.

You can now proceed to the Exercise 12 and 13.

Summary of Digital Logics labs

Imperial College London

- *Lab 1:* Boolean algebra, logic gates and identities, p-/n-CMOS as switches
- *Lab 2:* Binary numbers, binary addition, half-adders, full-adders
- *Lab 3:* 4-bit addition machine, signed binary representation
- *Lab 4:* binary subtraction and 4-bit subtraction machine
- *Lab 5:* 4-bit addition-subtraction machine, multiplexers
- *Lab 6:* 4-operation arithmetic-logic unit

Thoughts?