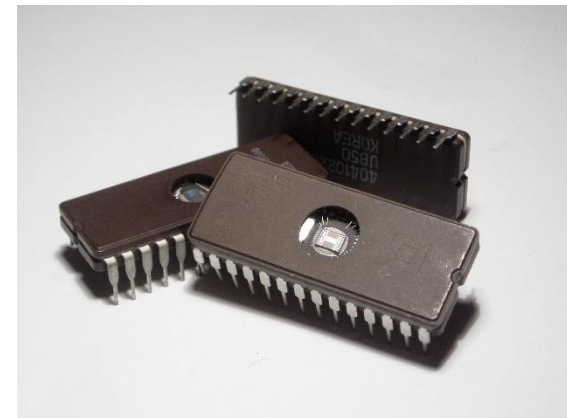# CHIP

ND USE

Bernhard Kainz (with thanks to **N. Dulay** and **E. Edwards**)

b.kainz@imperial.ac.uk

Integrated Circuits

- All ICs (chips) are made up of logic gates

- ICs are square pieces of silicon onto which logic gates have been depo

- Generally rows of a larger circuit

wikipedia

Assignment Project Exam Help

https://eduassistpro.github.io/

Add WeChat edu_assist_pro

IC – Sizes

Name	Abbreviation	Number of Gates
Small Scale Integra...		1-10
Medium Scale Integr...		10-100
Large Scale Integrated	...	100-100,000
Very Large Scale Integrated	VLSI	>100,000

Example SSI Chips

Assignment Project Exam Help

https://eduassistpro.github.io/

Add WeChat edu_assist_pro

7404 – hex inverter

7400 - Nand Gates   **The 7400 TTL series**

Example Circuit with SSI/MSI Chips

Assignment Project Exam Help

https://eduassistpro.github.io/

Add WeChat edu_assist_pro

MSI Chips – Multiplexer

- A multiple-input, single-output switch
- Also called MUX for short ☺

- sel selects which of I_0 or I_1 is mapped to the output
- For example, $sel = 0$ selects I_0 and $sel = 1$ selects I_1
- Example is called a 2-to-1 MUX
- With n *selects*/control lines, we can have 2^n input lines

MSI Chips – Multiplexer

- 2-to-1 Multiplexer

Assignment Project Exam Help

https://eduassistpro.github.io/

Add WeChat edu_assist_pro

Source: http://www.sparkfun.com/tutorials/371

MSI Chips – Multiplexer

• Truth Table

A	B	X	C	D	Y
0				0	0
0				0	0
0	1	0			0
0	1	1			1
1	0	0	1	0	1
1	0	1	0	0	0
1	1	0	1	0	1
1	1	1	0	1	1

MSI Chips – Multiplexer

- The 3 inputs **A**, **B**, **C** select which of the input lines (D_0-D_7) is through to the

- In general, a multiplexer has 2^n inputs and n control lines and one output

MSI Chips – Multiplexer

- Fits nicely into a 14-pin package (with ground and +5V)

MSI Chips – Demultiplexer

- A single-input, multiple-output switch
  - Opposite of a MUX
- Also called DEMUX ☺
- Usually used in

MSI Chips – Decoder

- A multiple-input, multiple-output logic circuit

  - Converts coded inputs into coded outputs

  - Binary Decoder

  - Necessary in applications such as ~~xing~~ and memory address decoding

MSI Chips – Decoder

- Only one output is 1 – the one selected by the n-bit put number – the zero

- ransmitting line selection with fewer wires (e.g. selecting a memory chip)

MSI Chips – Decoder

- Truth Table

A	B	C	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
0	0	0						0	0	1
0	0	1								0
0	1	0	0	0	0				0	0
0	1	1	0	0	0				0	0
1	0	0	0	0	0	1	0	0	0	0
1	0	1	0	0	1	0	0	0	0	0
1	1	0	0	1	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0

MSI Chips – Calculations – Comparator

- To compare two numbers

- Example: 1-bit comparison

  - Which gate to use? Assignment Project Exam Help

  - Recall: https://eduassistpro.github.io/

A	B	XOR
0	0	0
0	1	1
1	0	1
1	1	0

Add WeChat edu_assist_pro

MSI Chips – Calculations – Comparator

parator r   1

bit inputs A and

I, 0 otherwise

MSI Chips – Calculations – Bit-shifter

- Faster calculations for powers of 2
- Shift left and right (multiply and divide)

Assignment Project Exam Help

https://eduassistpro.github.io/

Add WeChat edu_assist_pro

- c = 0 → shift left
- c = 1 → shift right

The Arithmetic Logic Unit (ALU)

- Digital circuit that performs arithmetic and logical operations

- Fundamental building block of the central processing unit (CPU) of a computer
  - Even the simplest   for purposes such as maintaining timer
  - Processors found inside modern CP   ics processing units (GPUs) accommodate very powerful   plex ALUs

- Concept proposed in 1945 by Mathematician John von Neumann

- Research into ALUs remains an important part of computer science

ALU

- Recall: Full Adder

The Arithmetic Logic Unit (ALU)

Assignment Project Exam Help · The ALU is able to perform iple functions

https://eduassistpro.github.io/

Add WeChat edu_assist_pro ding on the input to der (F$_0$,F$_1$) one of four functions is selected – A and B, A or B, not B, arithmetic A+B

8-bit ALU

- Can link together 1-bit ALUs to form a multi-bit ALU
  - Sometimes known as bit-slice circuits

Assignment Project Exam Help

https://eduassistpro.github.io/

Add WeChat edu_assist_pro

CPU Design – VLSI

- Contains millions of gates – same structure as below

Assignment Project Exam Help

https://eduassistpro.github.io/

Add WeChat edu_assist_pro

CPU Design – VLSI

Assignment Project Exam Help

https://eduassistpro.github.io/

Add WeChat edu_assist_pro

Production

- Good video: https://www.youtube.com/watch?v=vK-geBYygXo

- Bad video: Assignment Project Exam Help
  https://www.you   aQJSyP8

  https://eduassistpro.github.io/

  Add WeChat edu_assist_pro