

Assignment Project Exam Help CHIP DESIGN AND USE

<https://tutorcs.com>

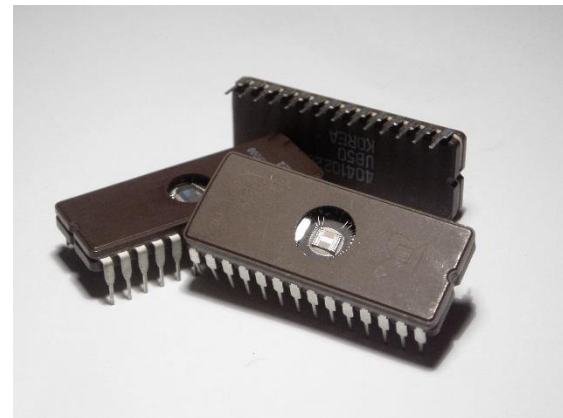
WeChat: cstutorcs

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

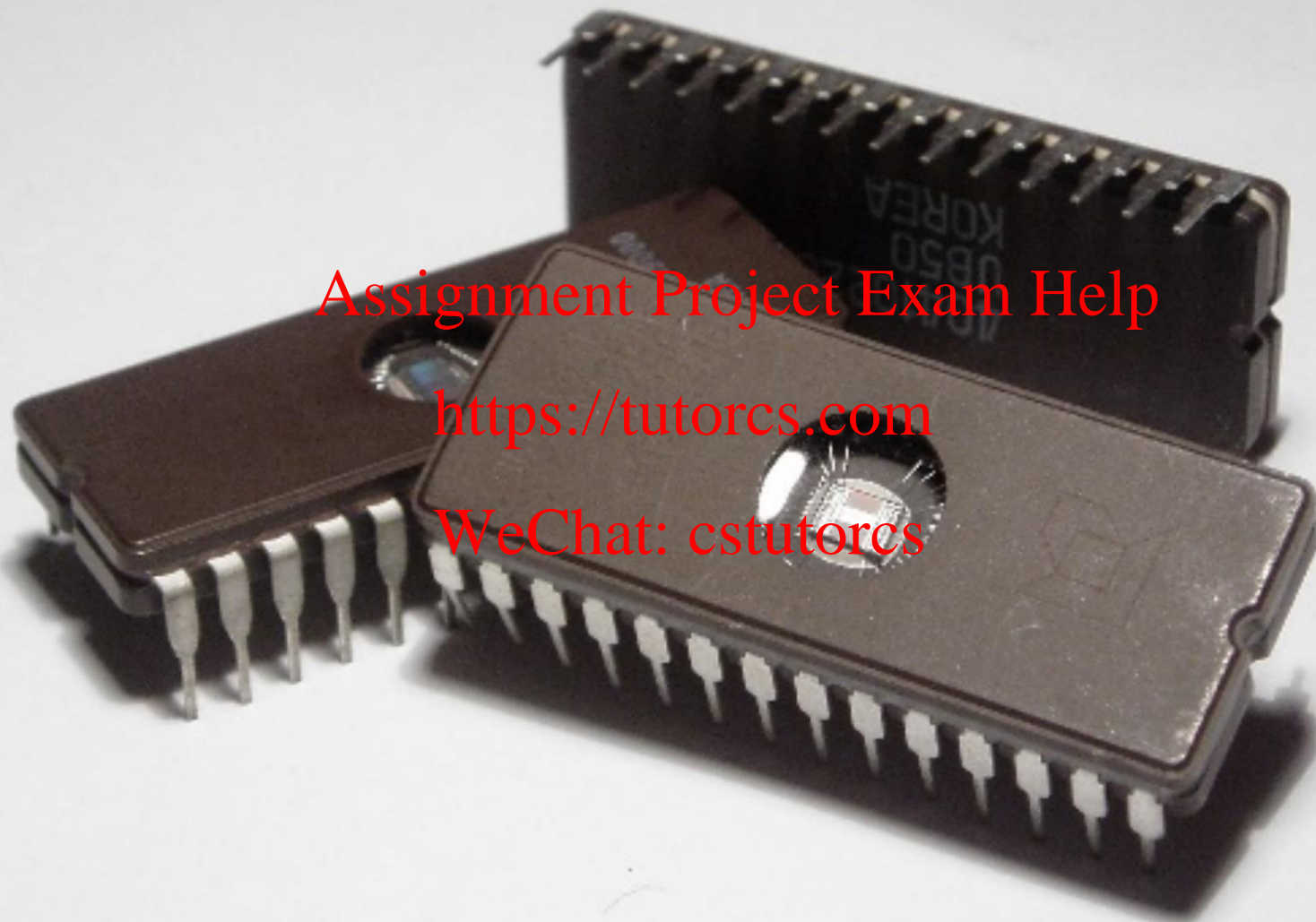
b.kainz@imperial.ac.uk

Integrated Circuits

- All ICs (chips) are made up of logic gates
- ICs are square pieces of silicon onto which logic gates have been deposited
- Generally rows of pins extend from each side of the chip



wikipedia



Assignment Project Exam Help

<https://tutorcs.com>

WeChat: cstutorcs

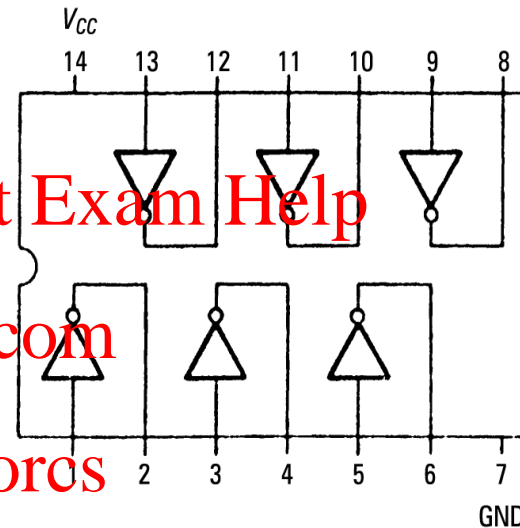
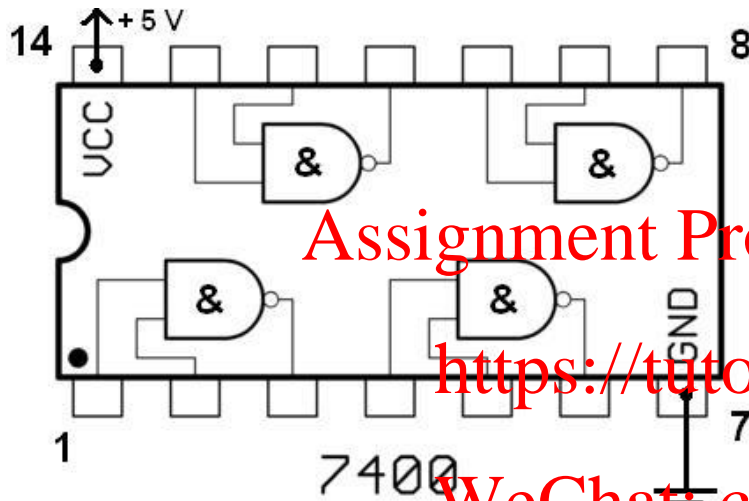
IC – Sizes

Assignment Project Exam Help		
Name	Abbreviation	Number of Gates
Small Scale Integrated	SSI	1-10
Medium Scale Integrated	MSI	10-100
Large Scale Integrated	LSI	100-100,000
Very Large Scale Integrated	VLSI	>100,000

<https://tutorcs.com>

WeChat: cstutorcs

Example SSI Chips



7404 – hex inverter



7400 - Nand Gates

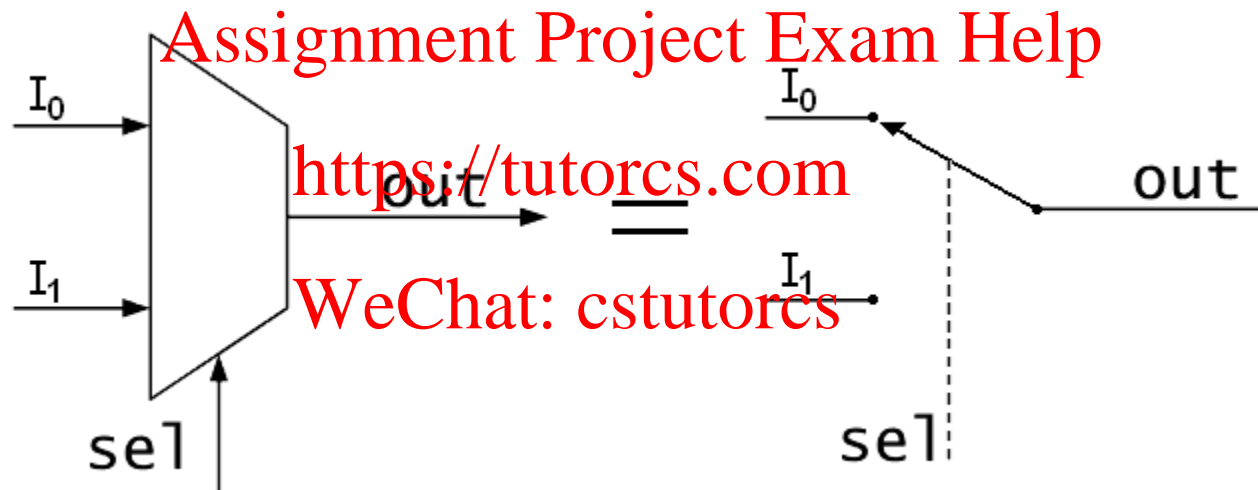
The 7400 TTL series

Example Circuit with SSI/MSI Chips



MSI Chips – Multiplexer

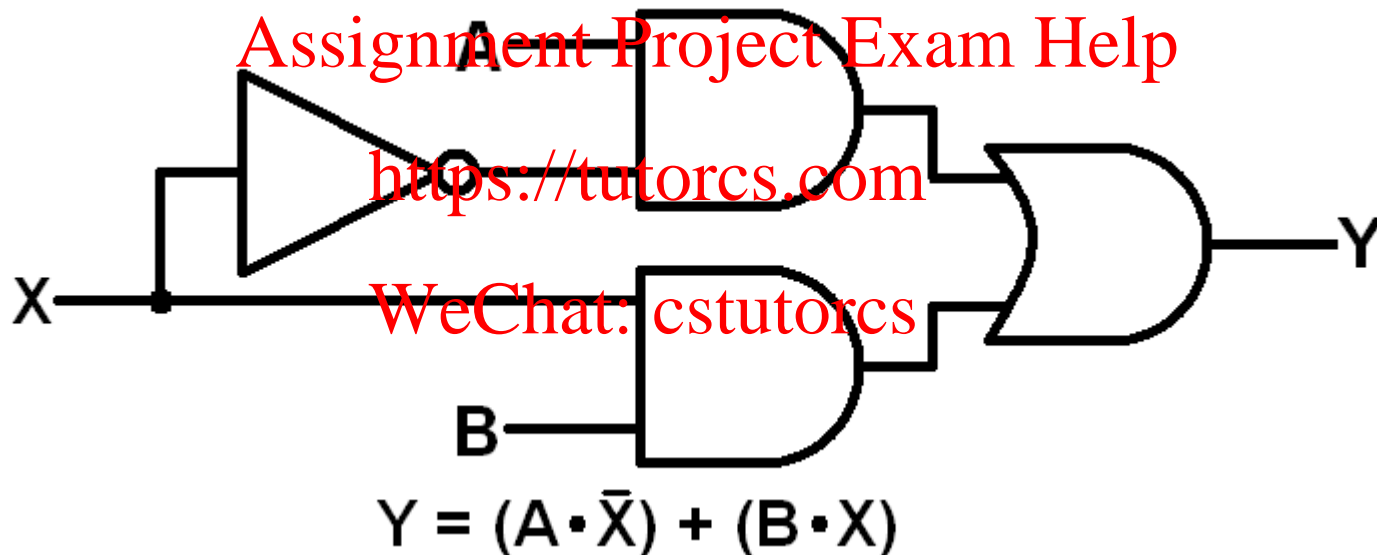
- A multiple-input, single-output switch
- Also called MUX for short 😊



- 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



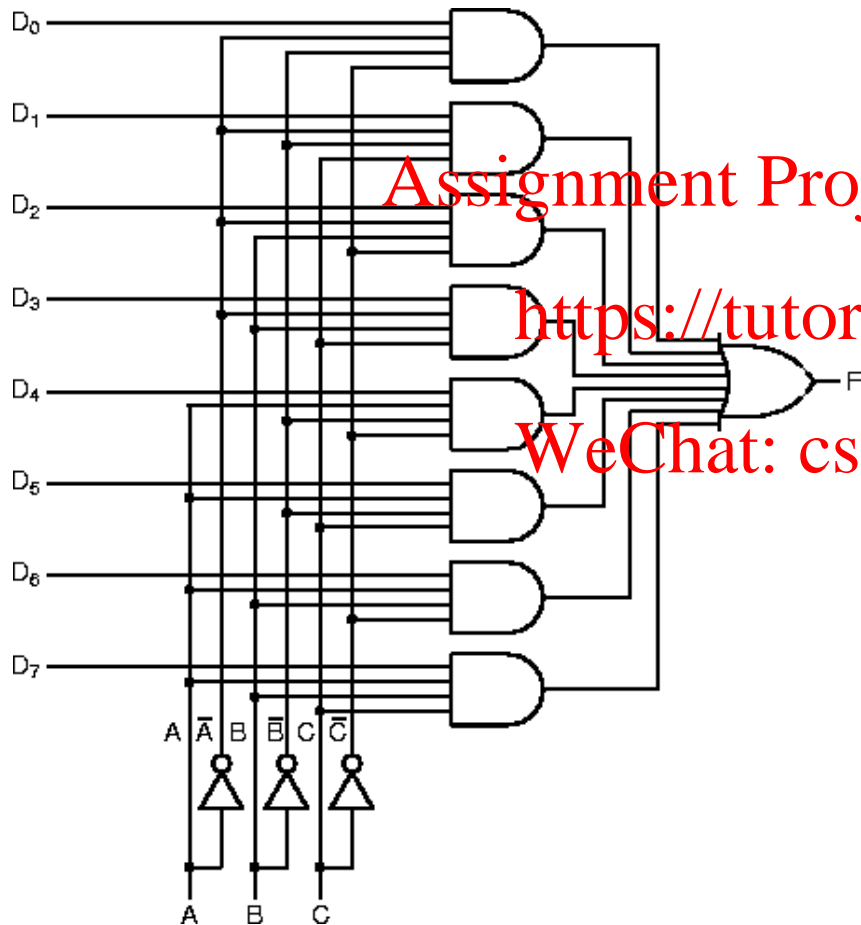
Source: <http://www.sparkfun.com/tutorials/371>

MSI Chips – Multiplexer

- Truth Table

A	B	X	A • X	B • X	Y
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	0	0
0	1	1	0	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

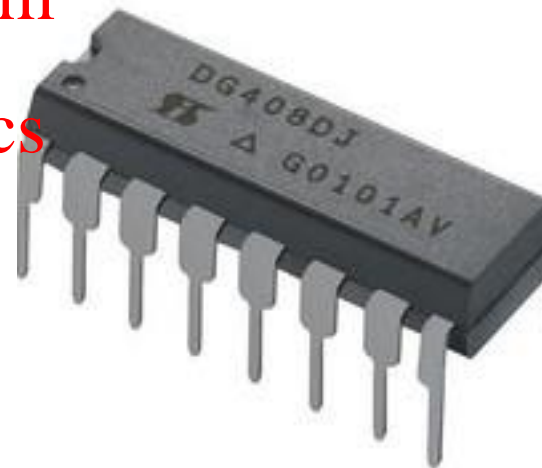
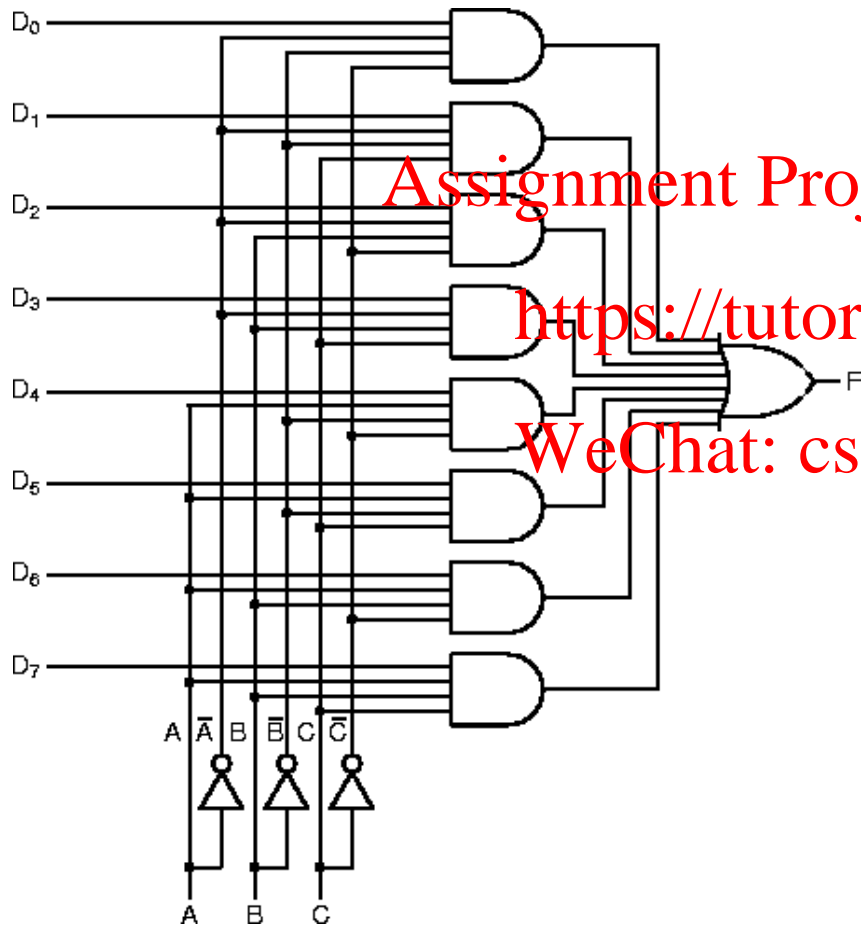


- The 3 inputs **A**, **B**, **C** select which of the input lines (D_0 - D_7) is copied through to the output **F**

- 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)



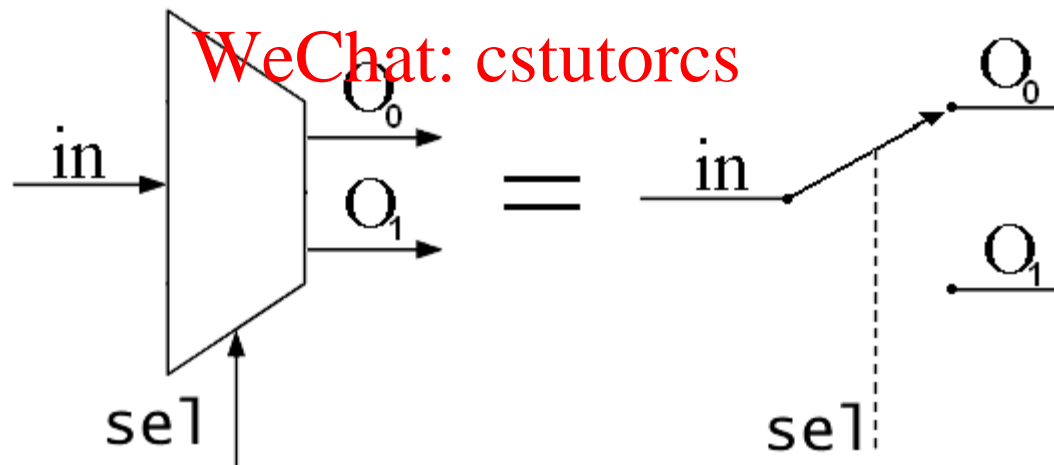
Assignment Project Exam Help

<https://tutorcs.com>

WeChat: cstutorcs

MSI Chips – Demultiplexer

- A single-input, multiple-output switch
 - Opposite of a MUX
 - Also called DEMUX ☹️
 - Usually used in conjunction with a MUX
- <https://tutorcs.com>



MSI Chips – Decoder

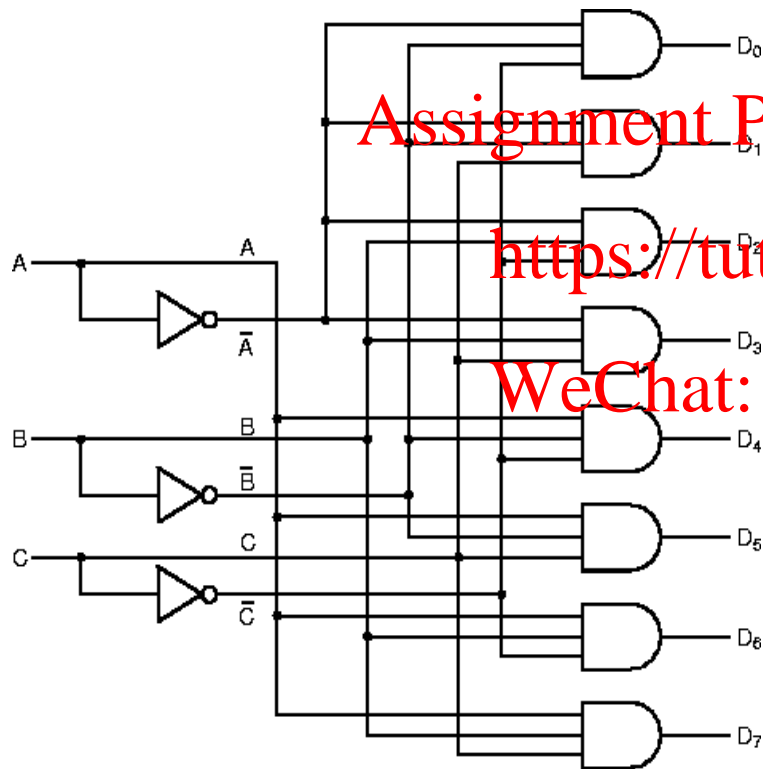
- A multiple-input, multiple-output logic circuit
 - Converts coded inputs into coded outputs
 - Binary Decoder has n inputs and 2^n outputs
 - Necessary in applications such as data multiplexing and memory address decoding

Assignment Project Exam Help

<https://tutorcs.com>

WeChat: cstutorcs

MSI Chips – Decoder



- Only one output is 1 – the one selected by the n-bit binary input number – the rest are zero
- Useful in transmitting 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	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	1	0	0	0	0	0	0	1	0	0
0	1	1	0	0	0	0	1	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

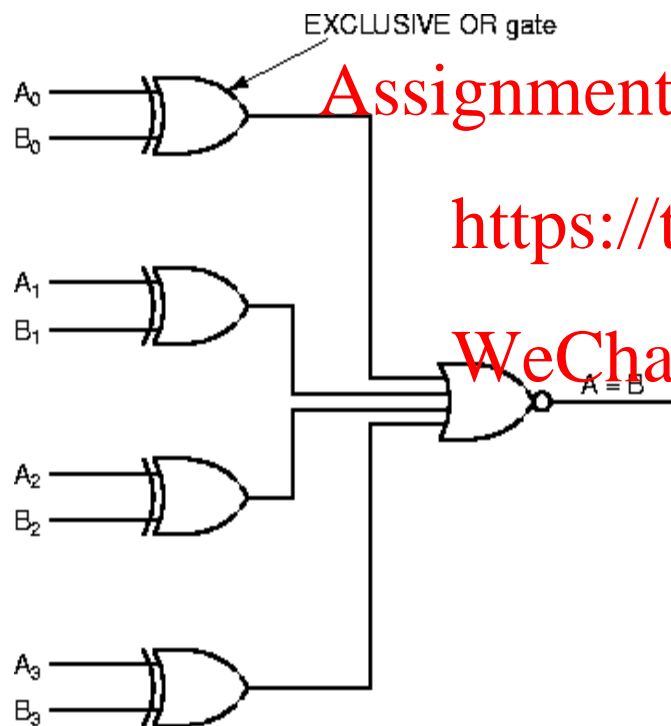
- Recall:

<https://tutorcs.com>

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

WeChat: cstutorcs

MSI Chips – Calculations – Comparator



Assignment Project Exam Help

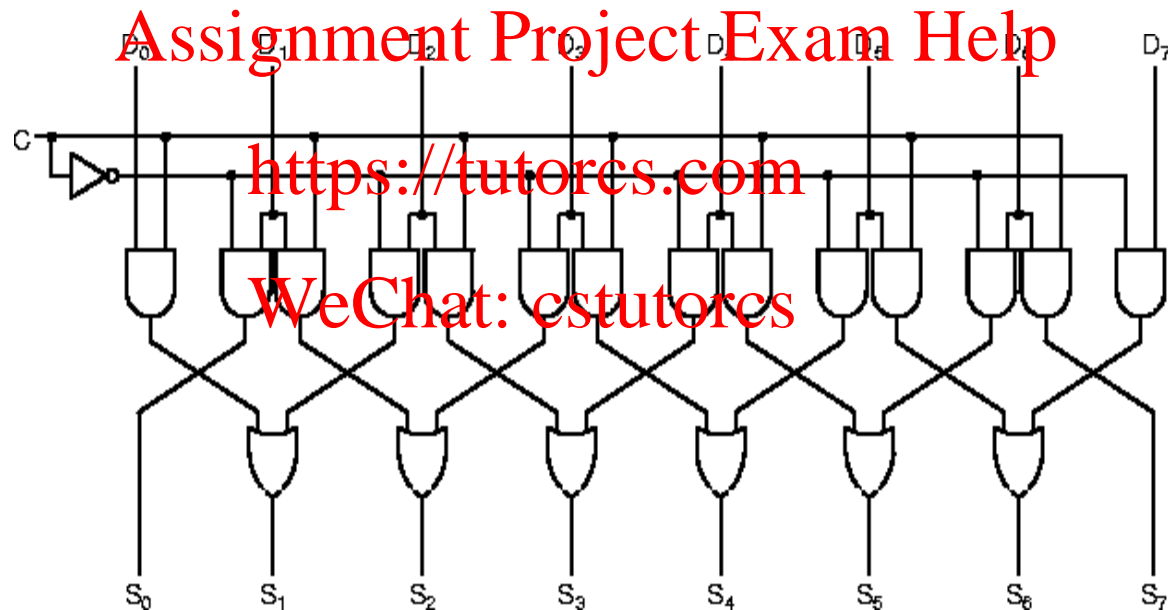
<https://tutorcs.com>

WeChat: cstutorcs

- The comparator returns 1 if the two n-bit inputs A and B are equal, 0 otherwise

MSI Chips – Calculations – Bit-shifter

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



- $c = 0 \rightarrow$ shift left
- $c = 1 \rightarrow$ shift right

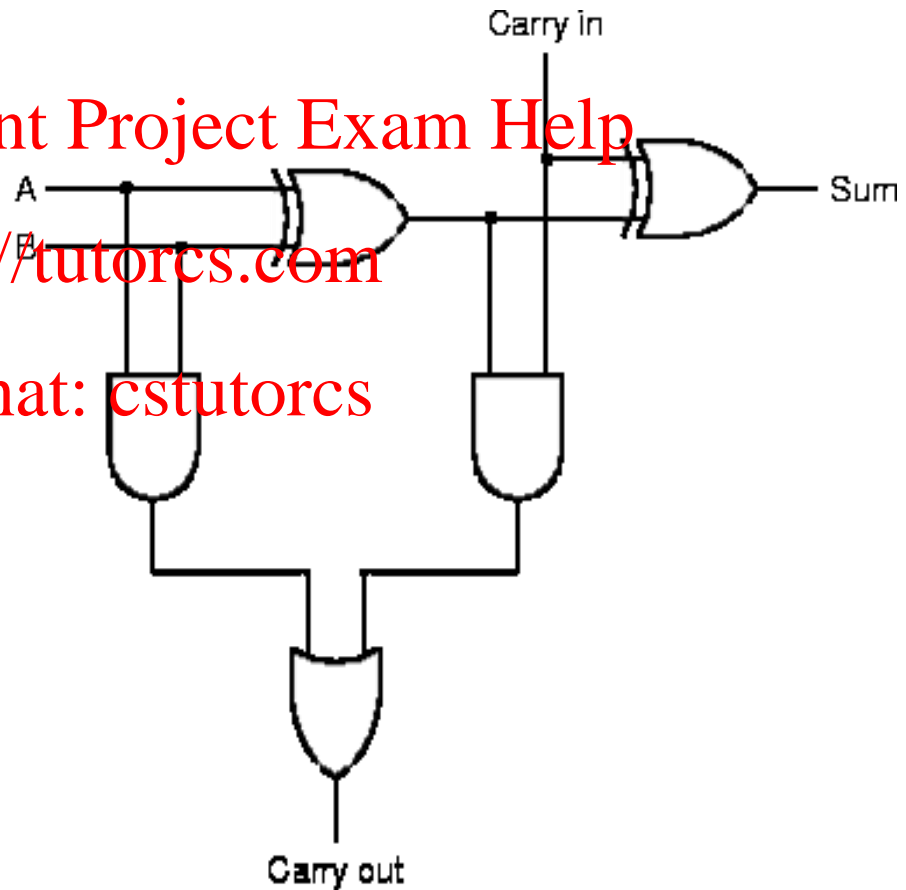
The Arithmetic Logic Unit (ALU)

- Digital circuit that performs arithmetic and logical operations
- Fundamental building block of the central processing unit (CPU) of a computer
 - Even the simplest microprocessors contain one for purposes such as maintaining timers
 - Processors found inside modern CPUs and graphics processing units (GPUs) accommodate very powerful and very complex ALUs
- Concept proposed in 1945 by Mathematician John von Neumann
- Research into ALUs remains an important part of computer science

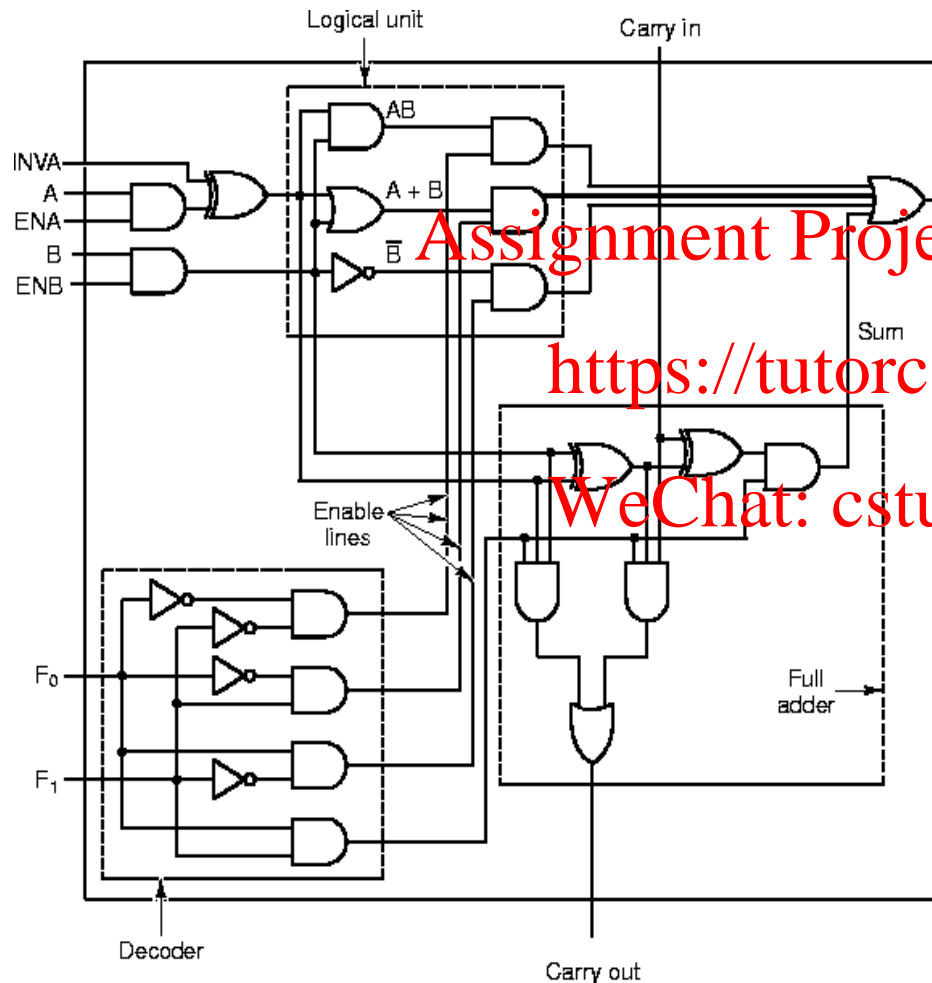
ALU

- Recall: Full Adder

A	B	Carry In	Sum	Carry out
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1



The Arithmetic Logic Unit (ALU)



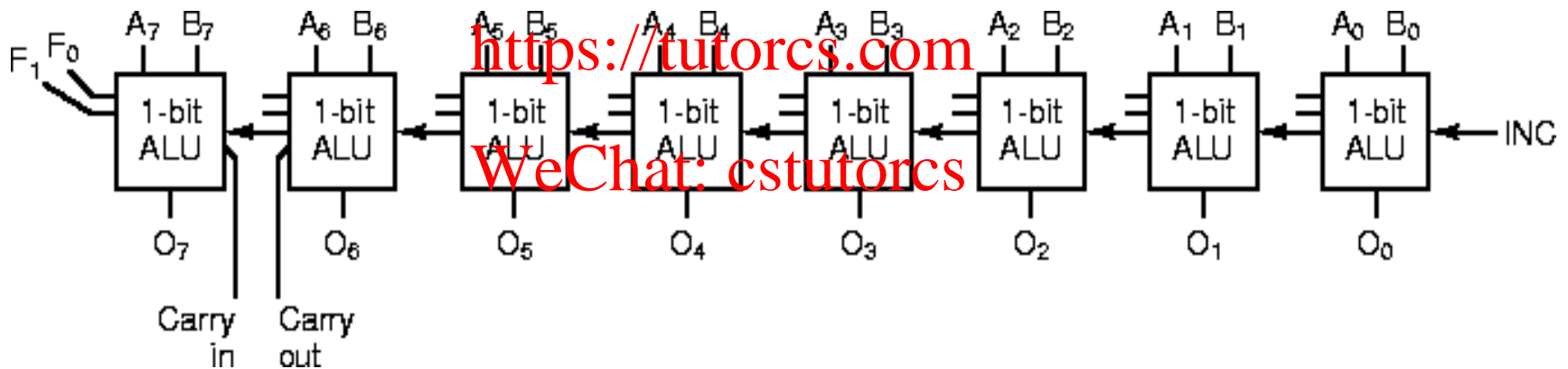
The ALU is able to perform multiple functions

- Depending on the input to the decoder (F₀, F₁) one of four functions is selected – A and B, A or B, not B, arithmetic A+B

8-bit ALU

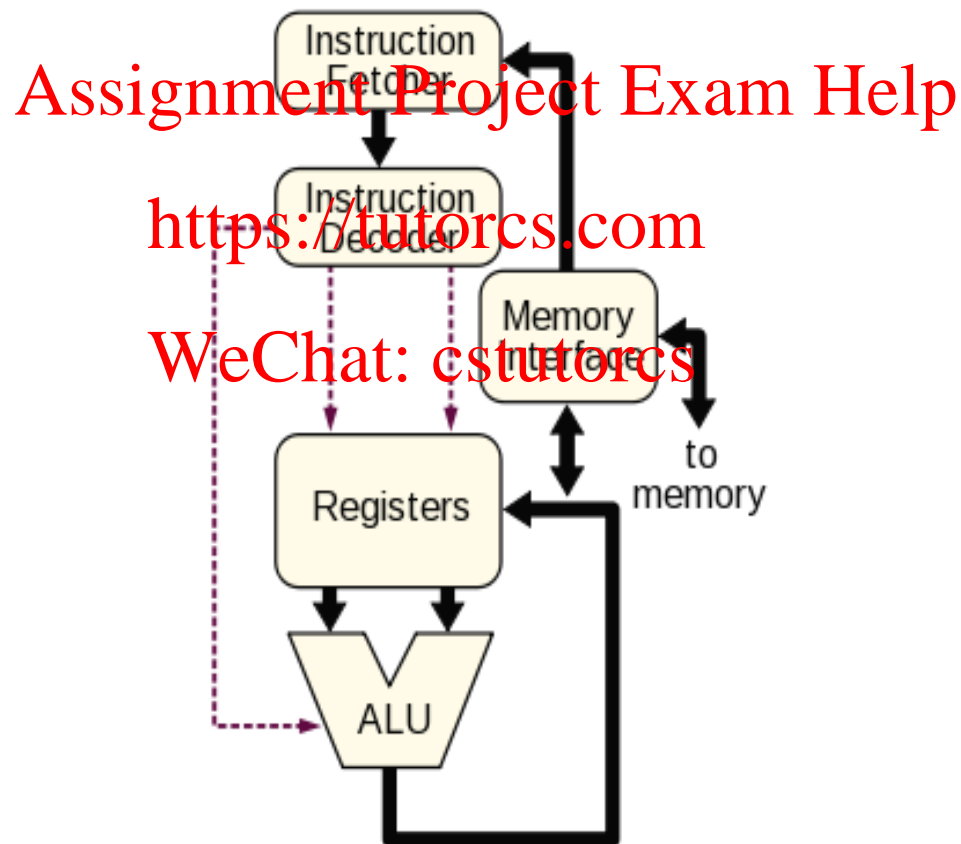
- Can link together 1-bit ALUs to form a multi-bit ALU
 - Sometimes known as bit-slice circuits

Assignment Project Exam Help

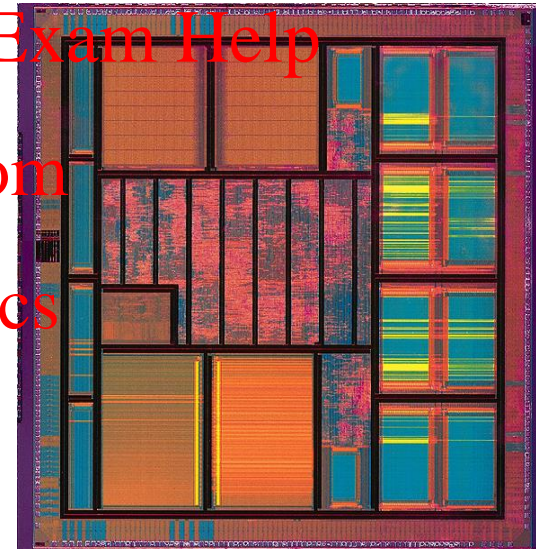
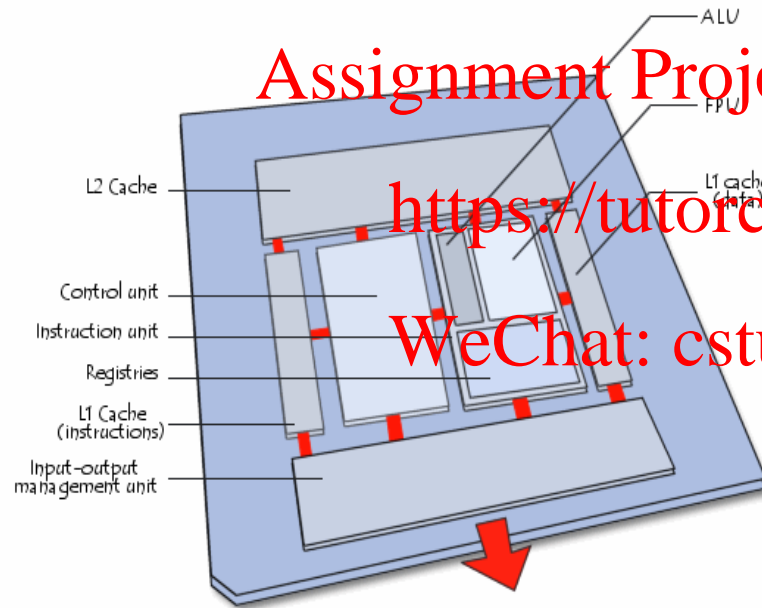


CPU Design – VLSI

- Contains millions of gates – same structure as below



CPU Design – VLSI



Assignment Project Exam Help

<https://tutorcs.com>

WeChat: cstutorcs

Production

- Good video:
<https://www.youtube.com/watch?v=vK-geBYygXo>
- Bad video: **Assignment Project Exam Help**
<https://www.youtube.com/watch?v=YIkMaQJSyP8>
<https://tutorcs.com>

WeChat: cstutorcs