

Topic 2 : Building a Computer

Fundamentals 2 : Computer Logic
Reference : D & L: Chapter 4.

Get Logic Gate Application from here:
<http://info.comp.lancs.ac.uk/year1/notes/csc131/>

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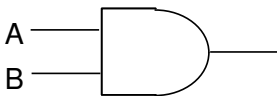
Introduction to Logic

AND
True OR False
NOT

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Logic Gates

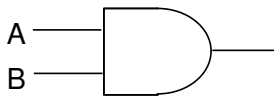
- AND



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Logic Gates

- AND

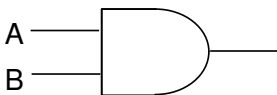


Input		Output
A	B	
F	F	
F	T	
T	F	
T	T	

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Logic Gates

- AND

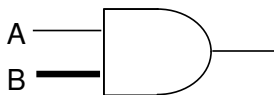


Input		Output
A	B	
F	F	
F	T	
T	F	F
T	T	

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Logic Gates

- AND

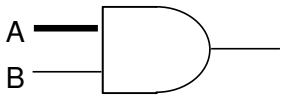


Input		Output
A	B	
F	F	F
F	T	F
T	F	
T	T	

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Logic Gates

- AND

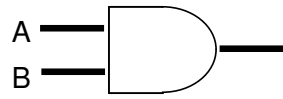


Input		Output
A	B	
F	F	F
F	T	F
T	F	F
T	T	F

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Logic Gates

- AND

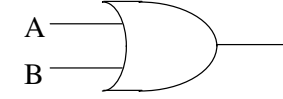


Input		Output
A	B	
F	F	F
F	T	F
T	F	F
T	T	T

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Logic Gates

- OR

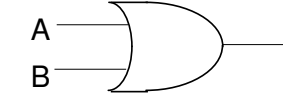


Input		Output
A	B	
F	F	
F	T	
T	F	
T	T	

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Logic Gates

- OR

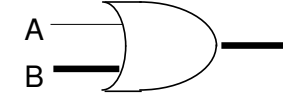


Input		Output
A	B	
F	F	F
F	T	
T	F	
T	T	

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Logic Gates

- OR

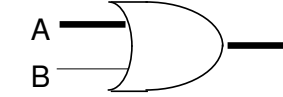


Input		Output
A	B	
F	F	F
F	T	T
T	F	
T	T	

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Logic Gates

- OR

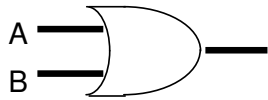


Input		Output
A	B	
F	F	F
F	T	T
T	F	T
T	T	T

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Logic Gates

- OR

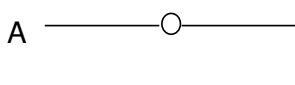


Input		Output
A	B	
F	F	F
T	F	T
F	T	T
T	T	T

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Logic Gates

- NOT

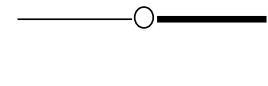


Input	Output
A	
F	T
T	F

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Logic Gates

- NOT

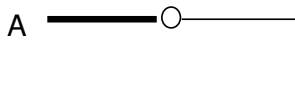


Input	Output
A	
F	T
T	F

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Logic Gate

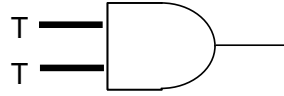
- NOT



Input	Output
A	
F	T
T	F

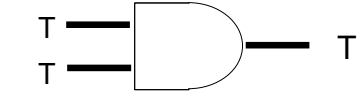
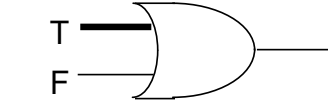
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Some Examples

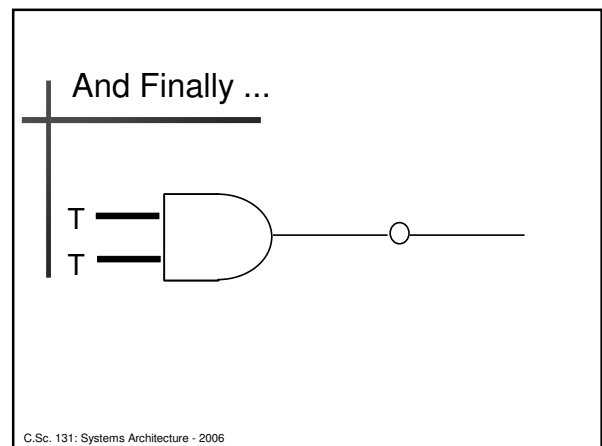
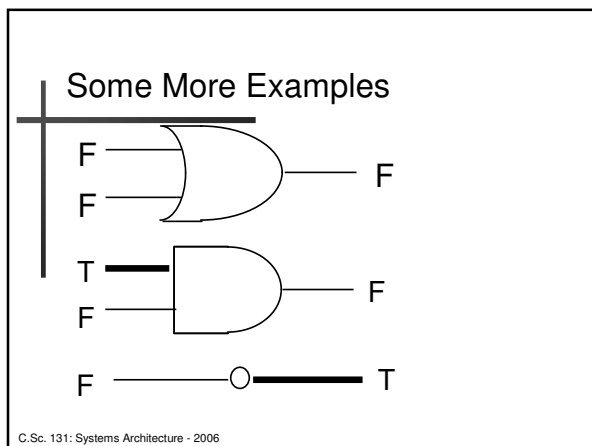
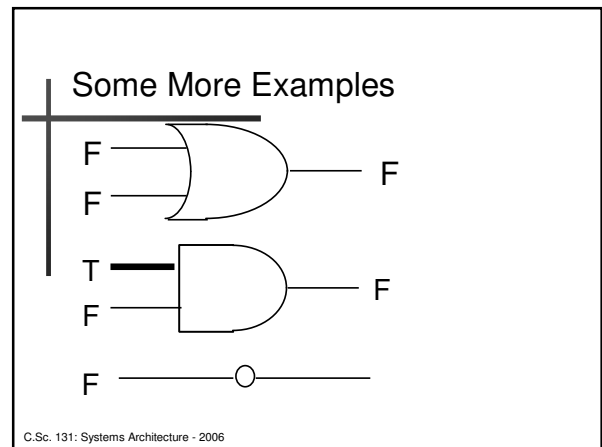
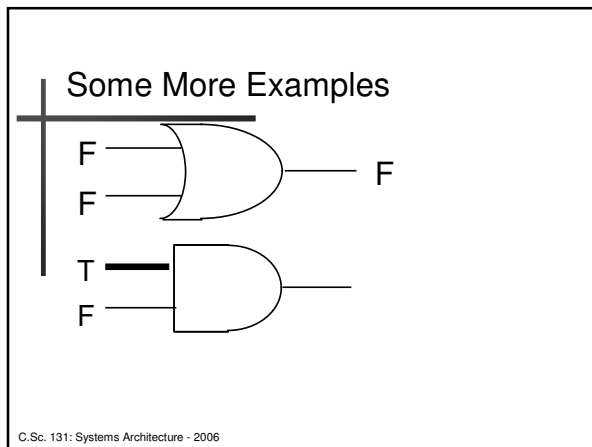
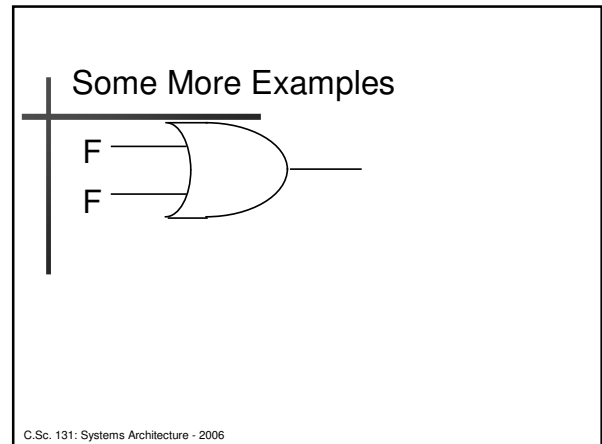
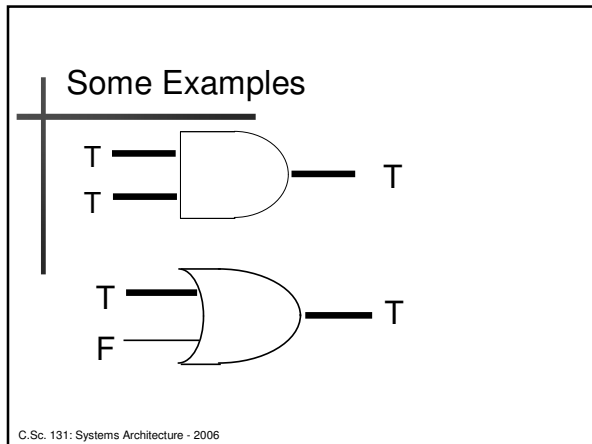


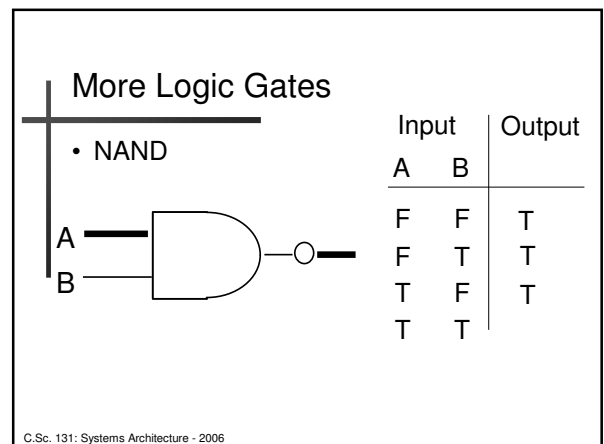
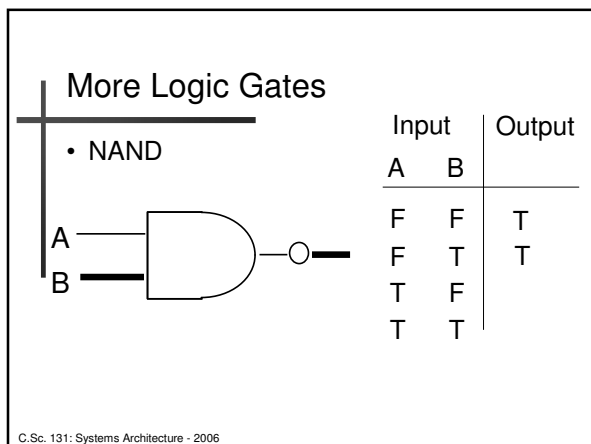
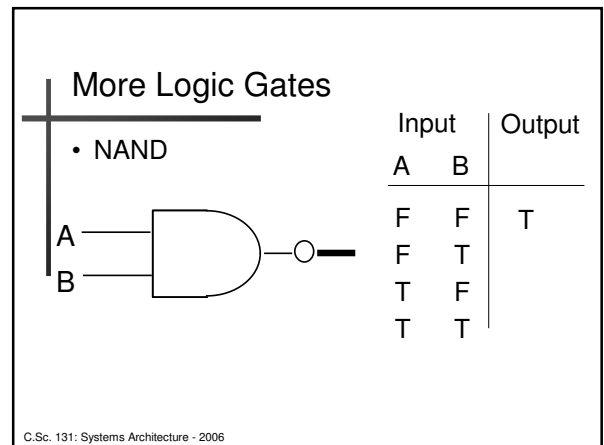
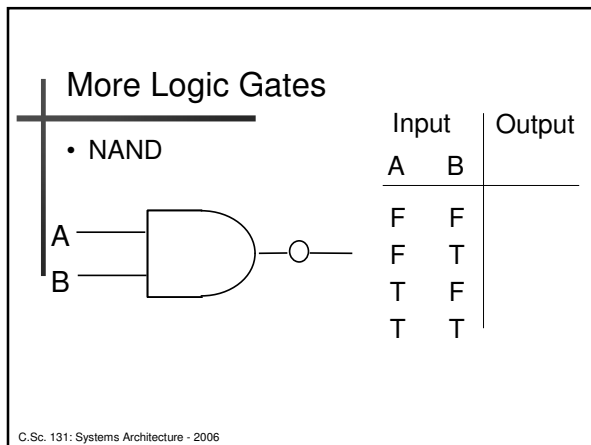
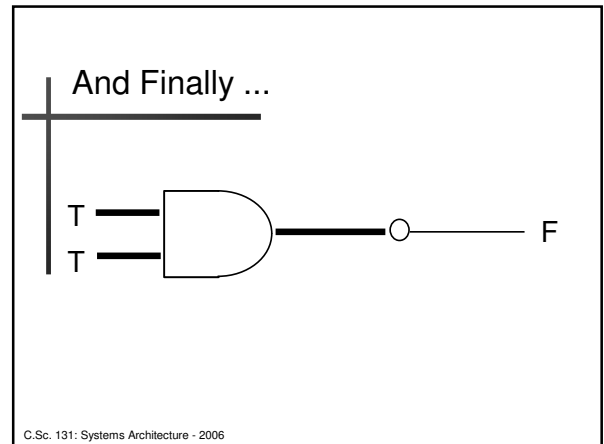
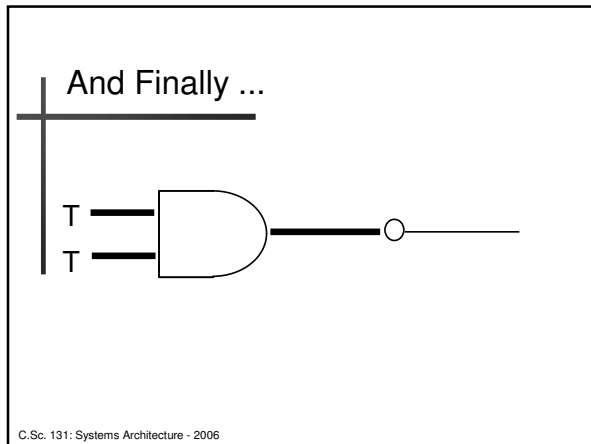
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Some Examples

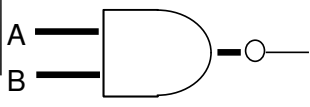
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More Logic Gates

- NAND

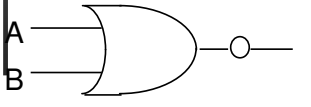


Input		Output
A	B	
F	F	T
F	T	T
T	F	T
T	T	F

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More Logic Gates ... contd.

- NOR

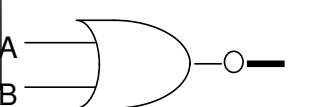


Input		Output
A	B	
F	F	T
F	T	F
T	F	F
T	T	F

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More Logic Gates .. contd.

- NOR

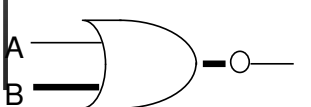


Input		Output
A	B	
F	F	T
F	T	F
T	F	F
T	T	F

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More Logic Gates .. contd.

- NOR

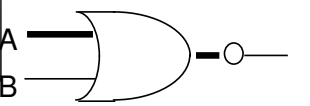


Input		Output
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F	T	F
T	F	F
T	T	F

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More Logic Gates .. contd.

- NOR

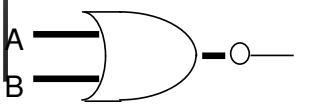


Input		Output
A	B	
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F	T	F
T	F	F
T	T	F

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More Logic Gates ... contd.

- NOR

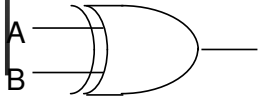


Input		Output
A	B	
F	F	T
F	T	F
T	F	F
T	T	F

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More Logic Gates ... contd.

• XOR

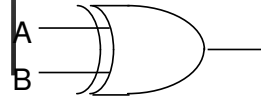


Input		Output
A	B	
F	F	
F	T	
T	F	
T	T	

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More Logic Gates ... contd.

• XOR

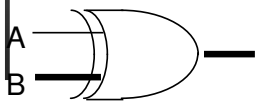


Input		Output
A	B	
F	F	F
F	T	
T	F	
T	T	

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More Logic Gates ... contd.

• XOR

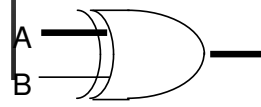


Input		Output
A	B	
F	F	F
F	T	T
T	F	
T	T	

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More Logic Gates ... contd.

• XOR

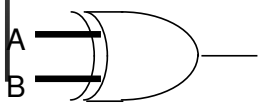


Input		Output
A	B	
F	F	F
F	T	T
T	F	T
T	T	

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More Logic Gates ... contd.

• XOR



Input		Output
A	B	
F	F	F
F	T	T
T	F	T
T	T	F

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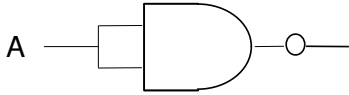
Properties of NAND & NOR Gates

- All the other gates can be implemented in terms of either NAND gates or NOR gates.
- Question: What would NOT and AND gates look like implemented using NAND gates?

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Properties of NAND & NOR Gates

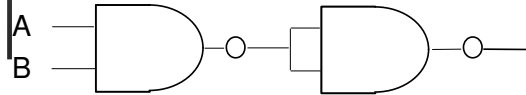
- Tie the inputs together.



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An AND Gate Built Using NAND Gates

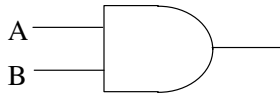
- Use a NOT gate to 're-invert' the output.



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Using Logic Gates

- Logic gates can be used to store and manipulate binary information if we replace T and F with 1 and 0.



Input		Output
A	B	
0	0	0
0	1	0
1	0	0
1	1	1

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Binary Addition Using Logic Gates

0 0 1 0 1 0 1 0 = 42

0 0 0 1 1 1 1 1 = 31

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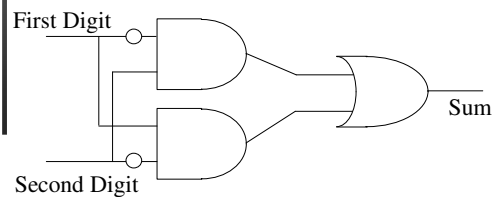
Designing the Circuit – the Sum...

0 0 1 0 1 0 1 0 = 42

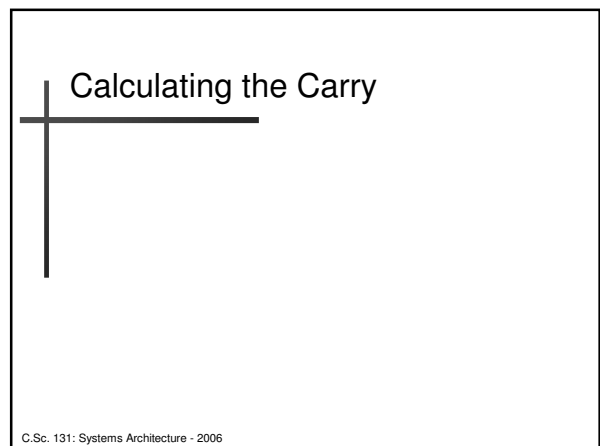
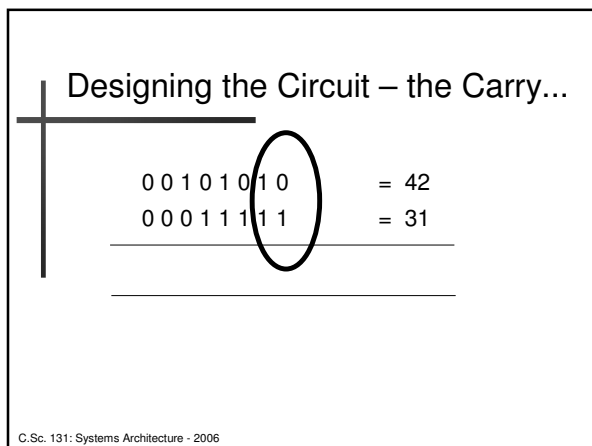
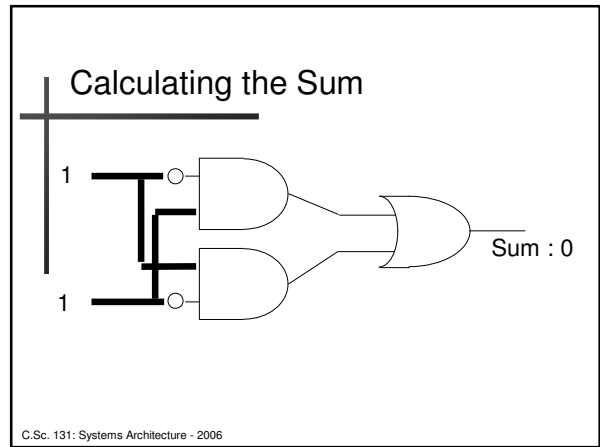
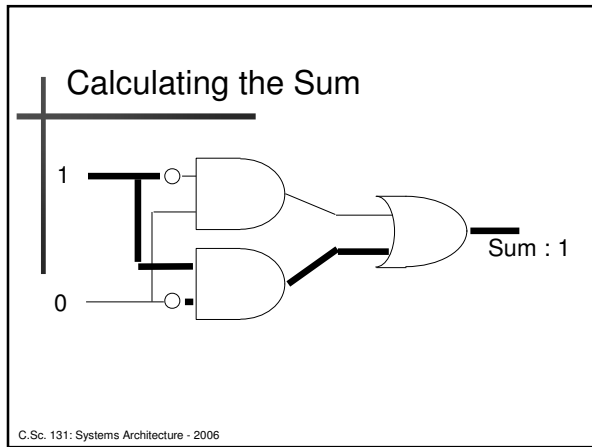
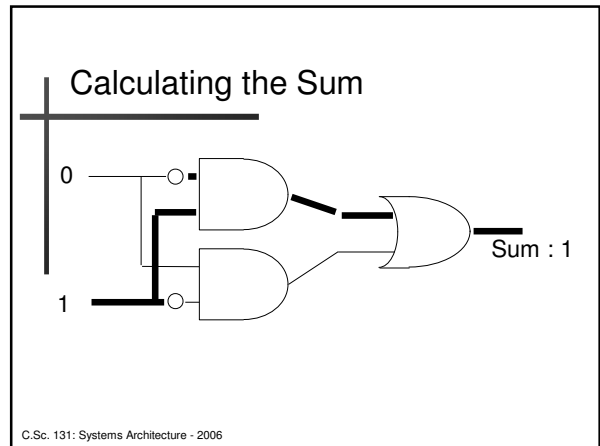
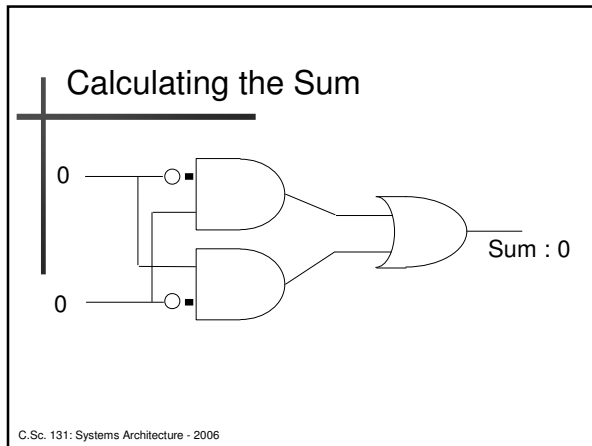
0 0 0 1 1 1 1 1 = 31

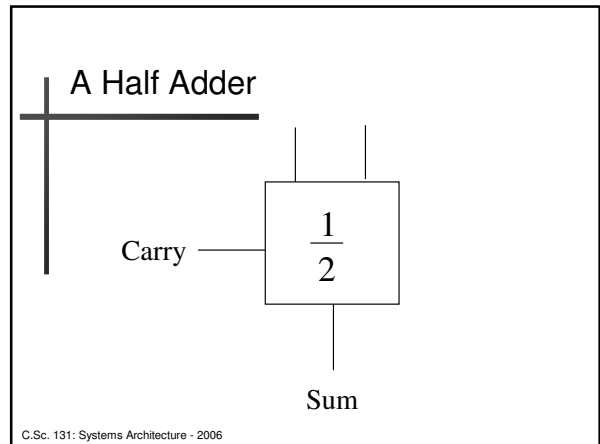
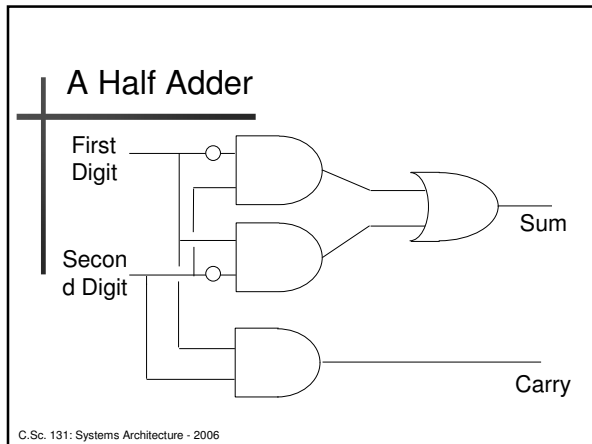
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Calculating the Sum



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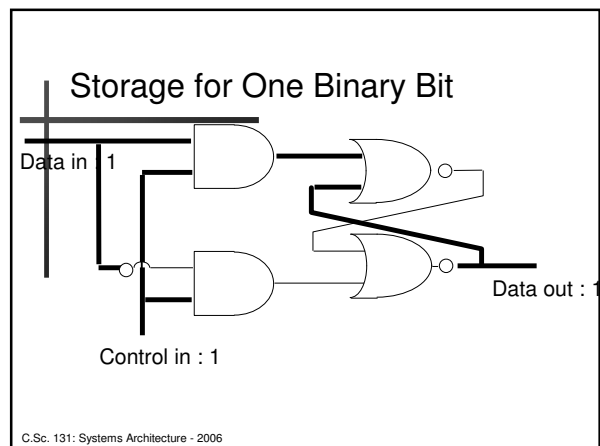
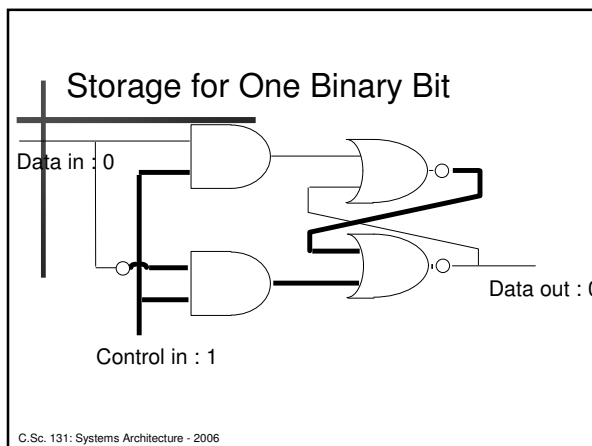
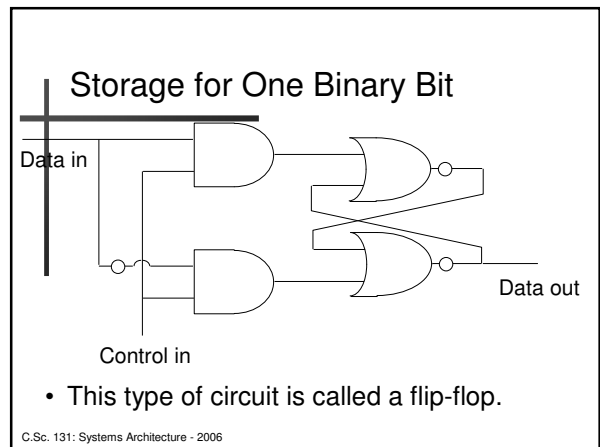


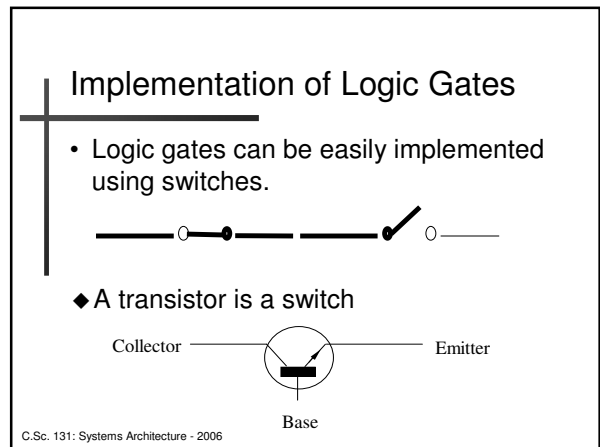
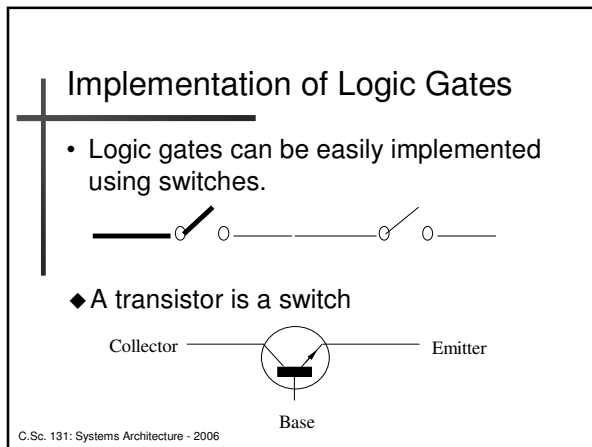
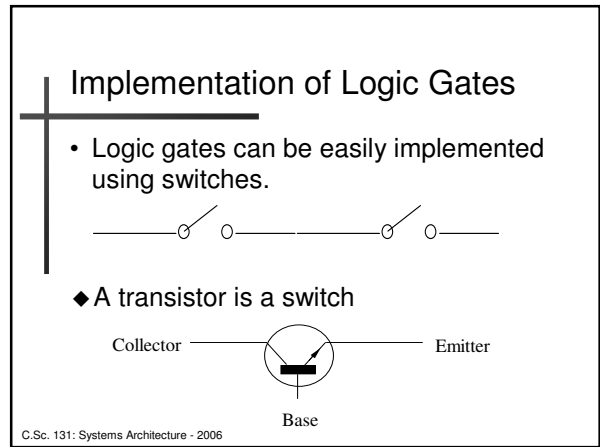
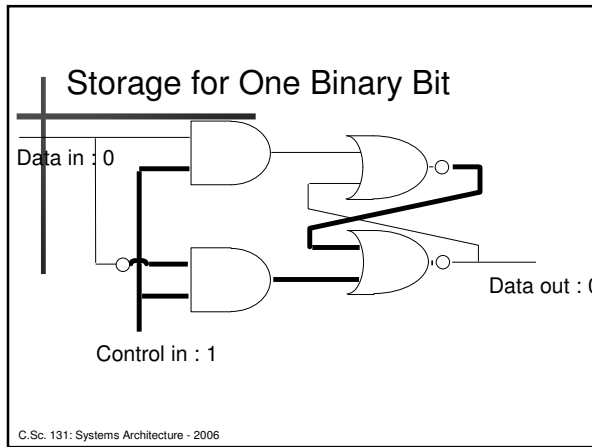
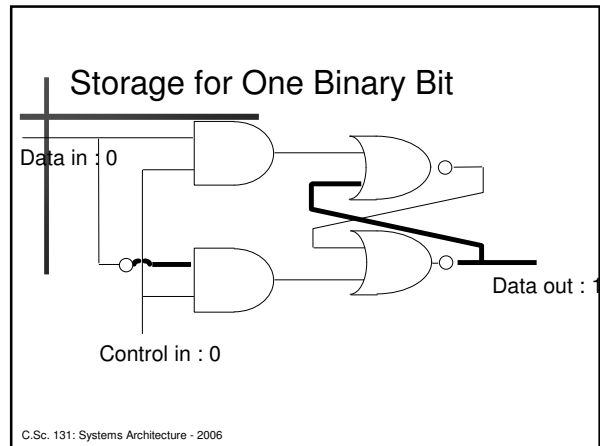
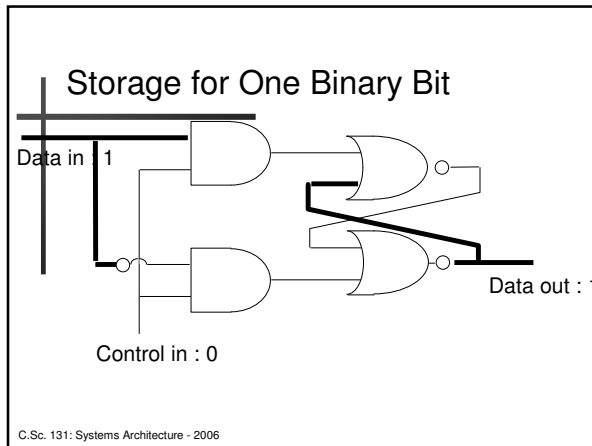
Demo: Adder for Two 4-bit Numbers

- We can combine 1/2 adders to form complete adders.
- Only ever need a half adder for the first pair of digits.

#1

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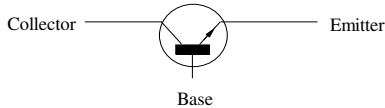


Implementation of Logic Gates

- Logic gates can be easily implemented using switches.



- ◆ A transistor is a switch



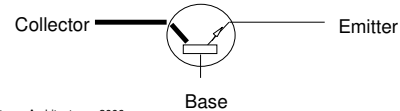
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Implementation of Logic Gates

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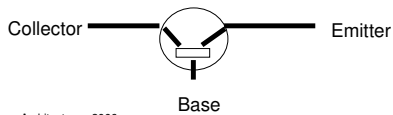
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Implementation of Logic Gates

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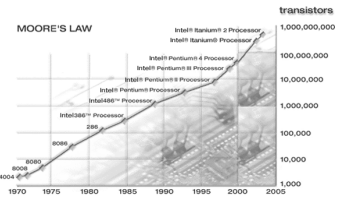
- ◆ A transistor is a switch



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Implementation of Logic Gates

- Large numbers of transistors can be built onto a single chip
 - How many transistors on Pentium 4?
- i.e. large numbers of gates can be built onto a single chip.



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Summary

- There are three key types of logic gate; AND, OR and NOT.
- Logic gates can be assembled to form circuits.
- Such circuits can be used to store and manipulate binary information.
- Logic gates can be built cheaply out of transistors.

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Coming this afternoon

- Topic 3 - Assembling our components to build a stored program computer,
- Reference : Handout.

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