Logic Gates

NOT

A	$\overline{A}$
0	1
1	0

A	B	AND $A \cdot B$	OR $A + B$	NAND $\overline{(A \cdot B)}$	NOR $\overline{(A + B)}$	XOR $A \oplus B$	XNOR $A \odot B$
0	0	0	0	1	1	0	1
0	1	0	1	1	0	1	0
1	0	0	1	1	0	1	0
1	1	1	1	0	0	0	1

A	B	C	AND $A \cdot B \cdot C$	OR $A + B + C$	NAND $\overline{(A \cdot B \cdot C)}$	NOR $\overline{(A + B + C)}$
0	0	0	0	0	1	1
0	0	1	0	1	1	0
0	1	0	0	1	1	0
0	1	1	0	1	1	0
1	0	0	0	1	1	0
1	0	1	0	1	1	0
1	1	0	0	1	1	0
1	1	1	1	1	0	0

etc..

Logic Identities of Boolean Algebra

(There are more, but they're the same as normal algebra)

$A \cdot 1 = A$ $\quad A + 0 = A$

$A \cdot 0 = 0$ $\quad A + 1 = 1$ (1st that's not like normal)

$A \cdot A = A$ $\quad A + A = A$

$A \cdot \overline{A} = 0$ $\quad A + \overline{A} = 1$

$A + A \cdot B = A$

$A + \overline{A} \cdot B = A + B$

$A \oplus B = A \cdot \overline{B} + \overline{A} \cdot B$

$\overline{A \oplus B} = A \odot B = A \cdot B + \overline{A} \cdot \overline{B}$

DeMorgan's Theorem

$\overline{(A \cdot B)} = \overline{A} + \overline{B}$ =

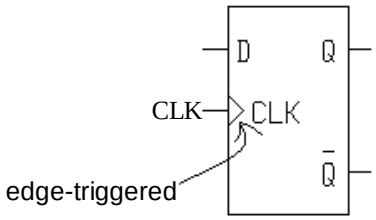
$\overline{(A + B)} = \overline{A} \cdot \overline{B}$ =

ECE 1250 Basics of Flip-Flops (Beginning Sequential Logic) A.Stolp 3/16/12 rev

D-Flip Flop

CLK	D	Q	$\overline{Q}$	Mode
*	X	Q	$\overline{Q}$	Hold
↓	0	0	1	Reset
↓	1	1	0	Set

* anything except a positive edge



Variations

Level triggered:
The level of the clock is important, not the edge. If D changes while the clock is high, Q will also change.

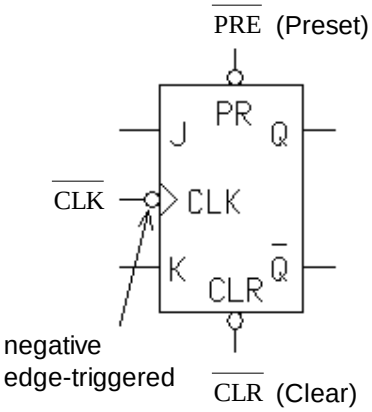
Negative edge-triggered: Responds at falling clock edges instead of rising edges, see J-K below.

With Preset and Clear: Nonsynchronous inputs to set set Q to 1 or reset (clear) Q, see J-K below. (Nonsynchronous means independant of the clock.)

JK-Flip Flop

$\overline{PRE}$	$\overline{CLR}$	$\overline{CLK}$	J	K	Q	$\overline{Q}$	Mode
0	1	X	X	X	1	0	Preset
1	0	X	X	X	0	1	Clear
0	0	X	X	X	1	1	not used
1	1	*	X	X	Q	$\overline{Q}$	Hold
0	0	X	0	0	Q	$\overline{Q}$	Hold
1	1	↓	0	1	0	1	Reset
1	1	↓	1	0	1	0	Set
1	1	↓	1	1	$\overline{Q}$	Q	Toggle

* anything except a negative edge



Variation Positive edge-triggered: Responds at rising clock edges instead of falling edges, see D above.

Basics of Binary Numbers

Binary: 1001111 = $1\cdot2^6+0\cdot2^5+0\cdot2^4+1\cdot2^3+1\cdot2^2+1\cdot2^1+1\cdot2^0=79$ (base 2)

Octal: 001 001 111 = 117o the little o at the end means octal (base 8)

Hex: 0100 1111 = 4Fh the little h at the end means hexidecimal (base 16)

Hex table	Octal	BCD
0 0000	000	0000
1 0001	001	0001
2 0010	010	0010
3 0011	011	0011
4 0100	100	0100
5 0101	101	0101
6 0110	110	0110
7 0111	111	0111
8 1000		1000
9 1001		1001
A 1010		
B 1011		
C 1100		
D 1101		
E 1110		
F 1111		

BCD (**B**inary-**C**oded **D**ecimal) 4829 = 0100 1000 0010 1001
4 8 2 9

$\frac{79}{2}=39.5$	39	Remainder 1	LSB
$\frac{39}{2}=19.5$	19	Remainder 1	
$\frac{19}{2}=9.5$	9	Remainder 1	
$\frac{9}{2}=4.5$	4	Remainder 1	
$\frac{4}{2}=2$	2	Remainder 0	
$\frac{2}{2}=1$	1	Remainder 0	
$\frac{1}{2}=0.5$	0	Remainder 1	MSB

79 = 100111 in binary