Digital Logic Lecture 02

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Radix Complements

Radix complements can be performed by this operation:

$$[(r^n - 1) - N] + 1$$

The 10's complement of 012398 is 987602.

The 10's complement of 246700 is 753300.

Complements II

Binary 2's complement will be the same with r=2

The 2's complement of 1101100 is 0010100.

The 2's complement of 0110111 is 1001001.

Subtract using complements

Subtract (M-N) can be performed in three steps:
1- Add M to r's complement of N
2- if M>N then M-N is obtained from step 1 just be discarding carry
3- if M<N take r's complement of step 1 and add negative sign bit

Subtraction II

Using 10's complement, subtract 72532 − 3250.

M =	72532
10's complement of N =	+ 96750
Sum =	169282
Discard end carry 10^5 =	−100000
Answer =	69282

Using 10's complement, subtract 3250 − 72532.

M =	03250
10's complement of N =	+ 27468
Sum =	30718

There is no end carry.

Answer: −(10's complement of 30718) = −69282

Subtraction III

Given the two binary numbers $X = 1010100$ and $Y = 1000011$, perform the subtraction (a) $X - Y$ and (b) $Y - X$ using 2's complements.

(a)

$X =$	1010100
2's complement of $Y =$	+ 0111101
Sum $=$	10010001
Discard end carry $2^7 =$	−10000000
Answer: $X - Y =$	0010001

(b)

$Y =$	1000011
2's complement of $X =$	+ 0101100
Sum $=$	1101111

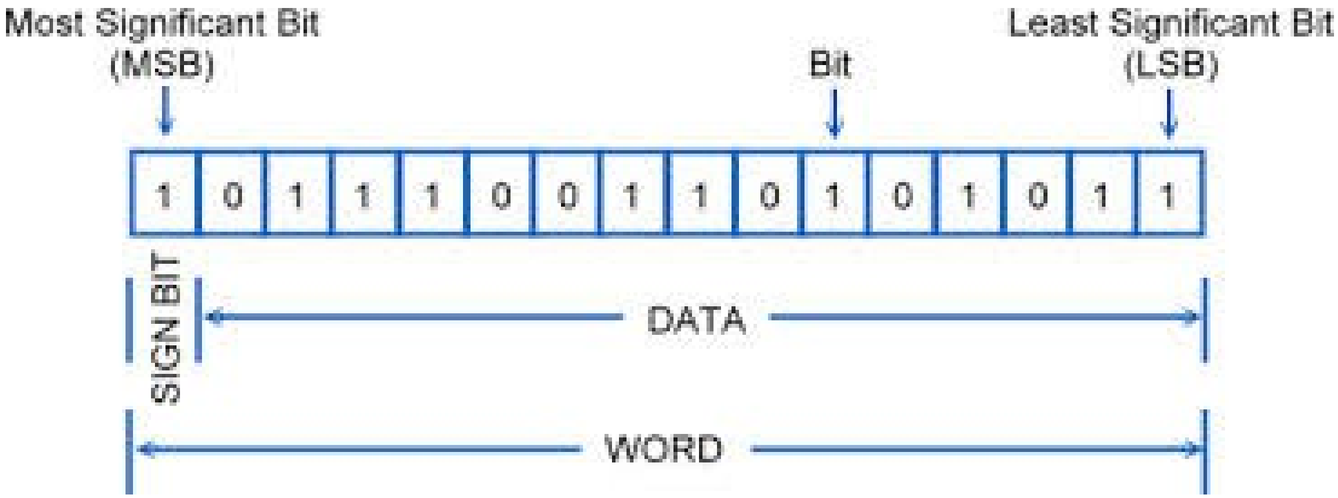
There is no end carry.

Answer: $Y - X = -$(2's complement of 1101111) $= -0010001$ ■

Signed Binary Numbers

It is customary to represent the sign with a bit placed in the leftmost position of the number. The convention is to make the sign

bit 0 for positive and I for negative.



Binary Codes

TABLE 1-2
Binary codes for the decimal digits

Decimal digit	(BCD) 8421	Excess-3	84-2-1	2421	(Biquinary) 5043210
0	0000	0011	0000	0000	0100001
1	0001	0100	0111	0001	0100010
2	0010	0101	0110	0010	0100100
3	0011	0110	0101	0011	0101000
4	0100	0111	0100	0100	0110000
5	0101	1000	1011	1011	1000001
6	0110	1001	1010	1100	1000010
7	0111	1010	1001	1101	1000100
8	1000	1011	1000	1110	1001000
9	1001	1100	1111	1111	1010000

Gray Code

TABLE 1-4
Four-bit Gray code

Gray code	Decimal equivalent
0000	0
0001	1
0011	2
0010	3
0110	4
0111	5
0101	6
0100	7
1100	8
1101	9
1111	10
1110	11
1010	12
1011	13
1001	14
1000	15

Binary Storage and Registers

- A register is a group of n Bits
- Usually we have 8 bits or 16 bits registers

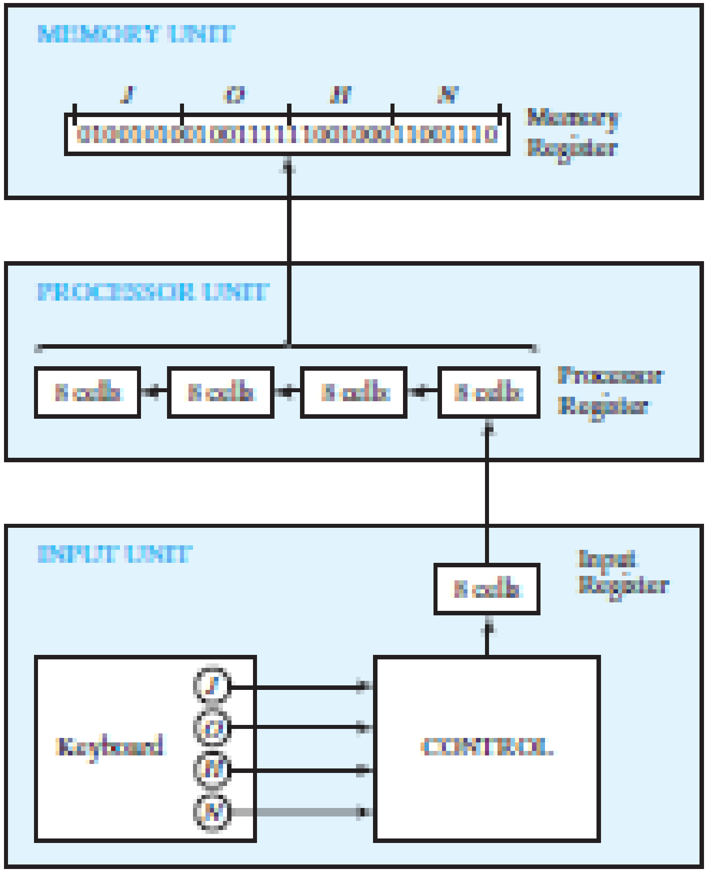
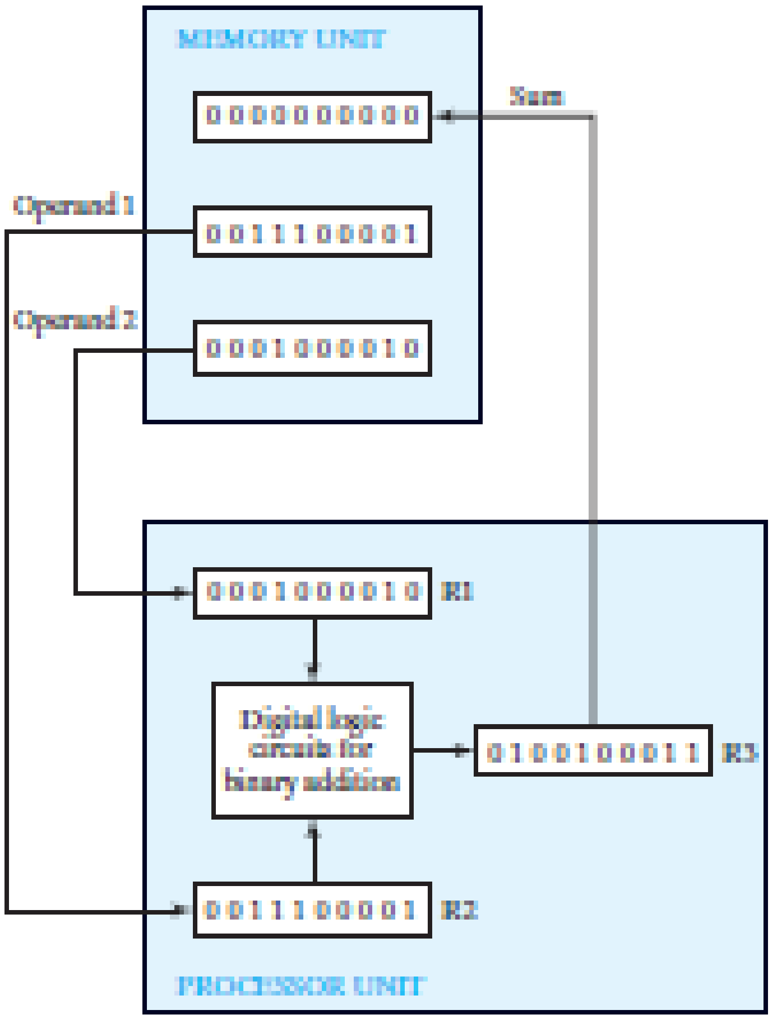


FIGURE 1.1
Transfer of information among registers

Binary Info processing



Binary Logic

Table 1.8
Truth Tables of Logical Operations

AND			OR			NOT	
x	y	$x \cdot y$	x	y	$x + y$	x	x'
0	0	0	0	0	0	0	1
0	1	0	0	1	1	1	0
1	0	0	1	0	1		
1	1	1	1	1	1		

Logic Gates

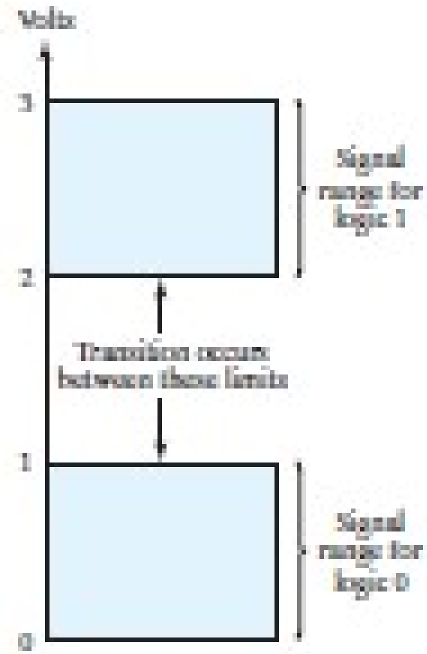
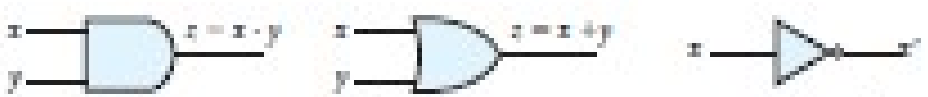


FIGURE 1.3
Signal levels for binary logic values



(a) Two-input AND gate (b) Two-input OR gate (c) NOT gate or inverter

FIGURE 1.4
Symbols for digital logic circuits

Logic gates II

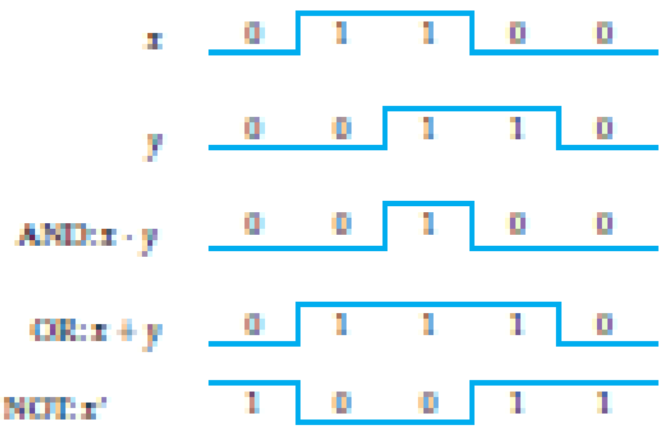
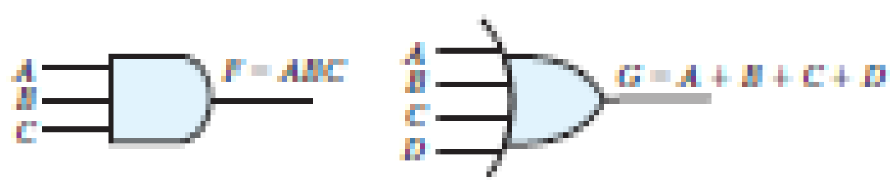


FIGURE 1.5
Input–output signals for gates



(a) Three-input AND gate (b) Four-input OR gate

FIGURE 1.6
Gates with multiple inputs