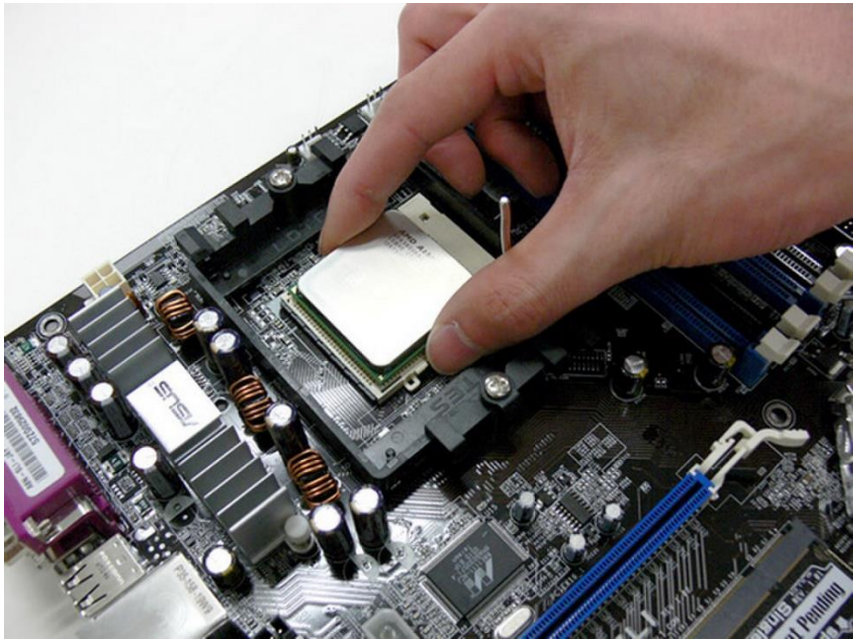
جامعة برج العرب
التكنولوجية



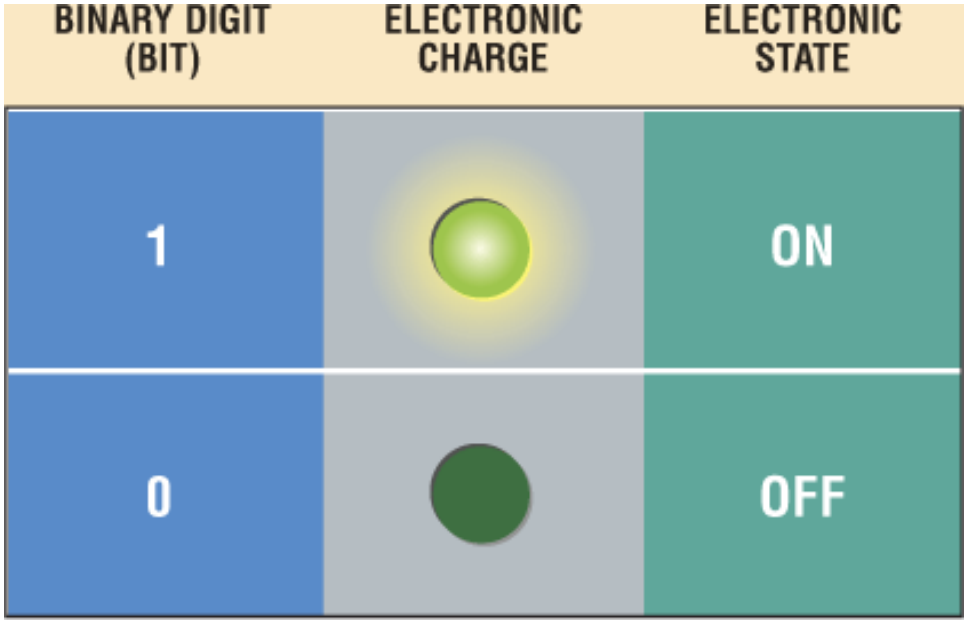
IT Essentials

د/ اسامه النحاس

Data Representation

Data Representation

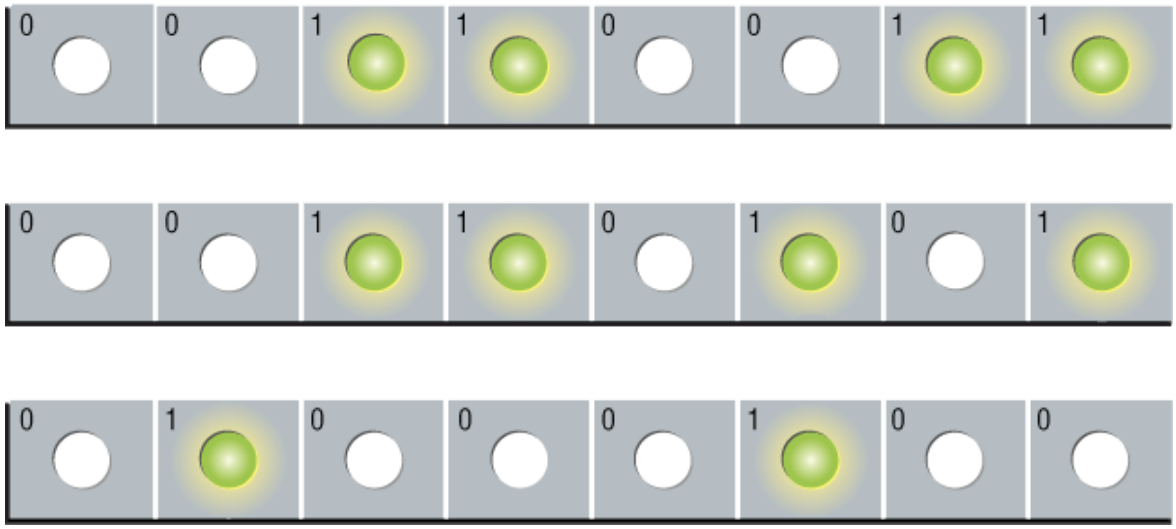
- How do computers represent data?
  - **Most computers are digital**



- Recognize only two discrete states: on or off
- Use a **binary system** to recognize two states
- Use number system with two unique digits: 0 and 1, called **bits** (short for binary digits)
  - Smallest unit of data computer can process

Data Representation

- What is a byte?
  - **Eight bits grouped together as a unit**
  - **Provides enough different combinations of 0s and 1s to represent 256 individual characters**
    - Numbers
    - Uppercase and lowercase letters
    - Punctuation marks



Number Systems

Number systems are very important to understand because the design and organization of a computer depends on the number systems. The four kind of number system used by the digital computer –

1. Decimal number system
2. Binary number system
3. Octal number system
4. Hexadecimal number system

Decimal Number System

- The decimal number system consists of 10 digits namely 0 to 9.

- Since the decimal number system consists of 10 digits, the base or radix of this system is 10.

e.g $(405)_{10}$, $(145.25)_{10}$

Octal Number System

- The octal number system consists of 8 digits namely 0 to 7.
- Since the Octal number system consists of 8 digits, the base or radix of this system is 8.

e.g $(76)_8$, $(55.25)_8$

Binary Number System

- The binary number system consists of 2 digits namely 0 and 1.
- Since the binary number system consists of 2 digits, the base or radix of this system is 2.

e.g $(101)_2$, $(1001.11)_2$

Hexadecimal Number System

- The Hexadecimal number system, popularly known as Hex system has 16 symbols, therefore its base/radix in 16.
- The 16 symbols used in Hexadecimal system are 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

e.g $(45)_{16}$, $(11A)_{16}$

Conversion between Number Systems

➢ Decimal into Binary

Step 1. Divide the decimal number by the base of binary using the repeated-division method.

Step 2. Note the remainder separately.

Step 3. Arrange the remainder in an order where the first remainder noted is LSD and the last remainder is MSD.

Conversion between Number Systems

- **Decimal into Binary**

Decimal number 225

Division	Quotient	Remainder
225 / 2	112	1 ← LSB
112 / 2	56	0
56 / 2	28	0
28 / 2	14	0
14 / 2	7	0
7 / 2	3	1
3 / 2	1	1
1 / 2	0	1

Binary number 1 1 1 0 0 0 0 1

Decimal number 77

Division	Quotient	Remainder
77 / 2	38	1 ← LSB
38 / 2	19	0
19 / 2	9	1
9 / 2	4	1
4 / 2	2	0
2 / 2	1	0
1 / 2	0	1
		0

Binary number 0 1 0 0 1 1 0 1

Converting Binary to Decimal

- Decimal number system is base 10
  - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
  - Uses 10 numbers

23625

Power of 10 representation	10^4	10^3	10^2	10^1	10^0
Decimal representation	**10000**	**1000**	**100**	**10**	**1**
Base 10 representation	**20,000**	**3,000**	**600**	**20**	**5**

Converting Binary to Decimal

Binary number system is base 2

- **0, 1**
- **Uses 2 numbers**

10010001

Base 2 representation	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Decimal representation	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
Base 2 representation	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**1**

Converting Binary to Decimal

Binary number system is base 2

- **0, 1**
- **Uses 2 numbers**

10010001 = 145

Base 2 representation	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Decimal representation	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
Base 2 representation	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**1**

Converting Decimal to Binary

- Convert decimal 35 to binary
  1. Using 8 bits, find largest power of 2 that will “fit” into 35
  2. Place a 1 into that slot
  3. If the # doesn’t fit, place a 0 into that slot

Power of 2 representation	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Decimal representation	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
Base 2 representation								

Converting Decimal to Binary

- Convert decimal 35 to binary
  1. Using 8 bits, find largest power of 2 that will "fit" into 35
  2. Place a 1 into that slot
  3. If the # doesn't fit, place a 0 into that slot

Power of 2 representation	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Decimal representation	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
Base 2 representation	0	0	1	0	0	0	1	1

35 = 00100011

Convert Binary to Decimal

1. Choose an 8 bit binary number = 10101110
2. Write the binary digits under the correct column
3. For each column with a 1, you will add that decimal value
4. You will not add the values of the columns you entered 0

Power of 2 representation								
Decimal representation								
Base 2 representation	**1**	**0**	**1**	**0**	**1**	**1**	**1**	**0**

Convert Binary to Decimal

1. Choose an 8 bit binary number = 10101110
2. Write the binary digits under the correct column
3. For each column with a 1, you will add that decimal value
4. You will not add the values of the columns you entered 0

Power of 2 representation	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Decimal representation	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
Base 2 representation	**1**	**0**	**1**	**0**	**1**	**1**	**1**	**0**

128 + 32 + 8 + 4 + 2 = 174

10101110 = 174

Data Representation

- What are three popular coding systems to represent data?

  - **ASCII—American Standard Code for Information Interchange**
  - **EBCDIC—Extended Binary Coded Decimal Interchange Code**
  - **Unicode—coding scheme capable of representing all world's languages**

ASCII	Symbol	EBCDIC
00110000	0	11110000
00110001	1	11110001
00110010	2	11110010
00110011	3	11110011

Data Representation

ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[END OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

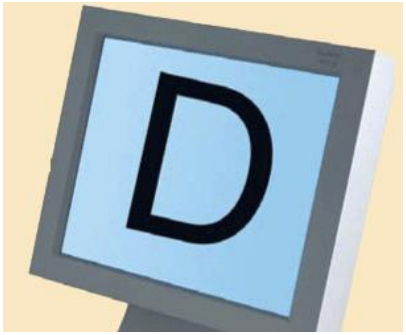
Data Representation

- How is a letter converted to binary form and back?

Step 1.
The user presses the capital letter **D** (shift+D key) on the keyboard.

Step 2.
An electronic signal for the capital letter **D** is sent to the system unit.

Step 3.
The signal for the capital letter **D** is converted to its ASCII binary code (01000100) and is stored in memory for processing.



Step 4.
After processing, the binary code for the capital letter **D** is converted to an image, and displayed on the output device.