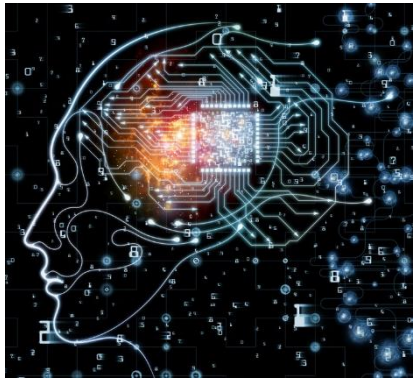
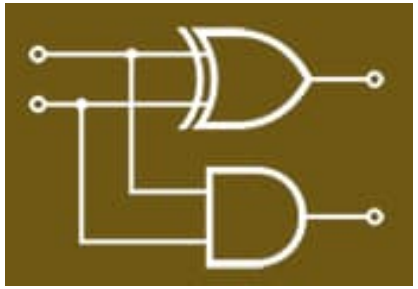
Number Systems Conversion with Shortcut Method

Binary ⟷ Decimal

Binary ⟷ HexaDecimal

Binary ⟷ Octal





Digital Logic and Design

Arfan Shahzad

{ arfanskp@gmail.com }

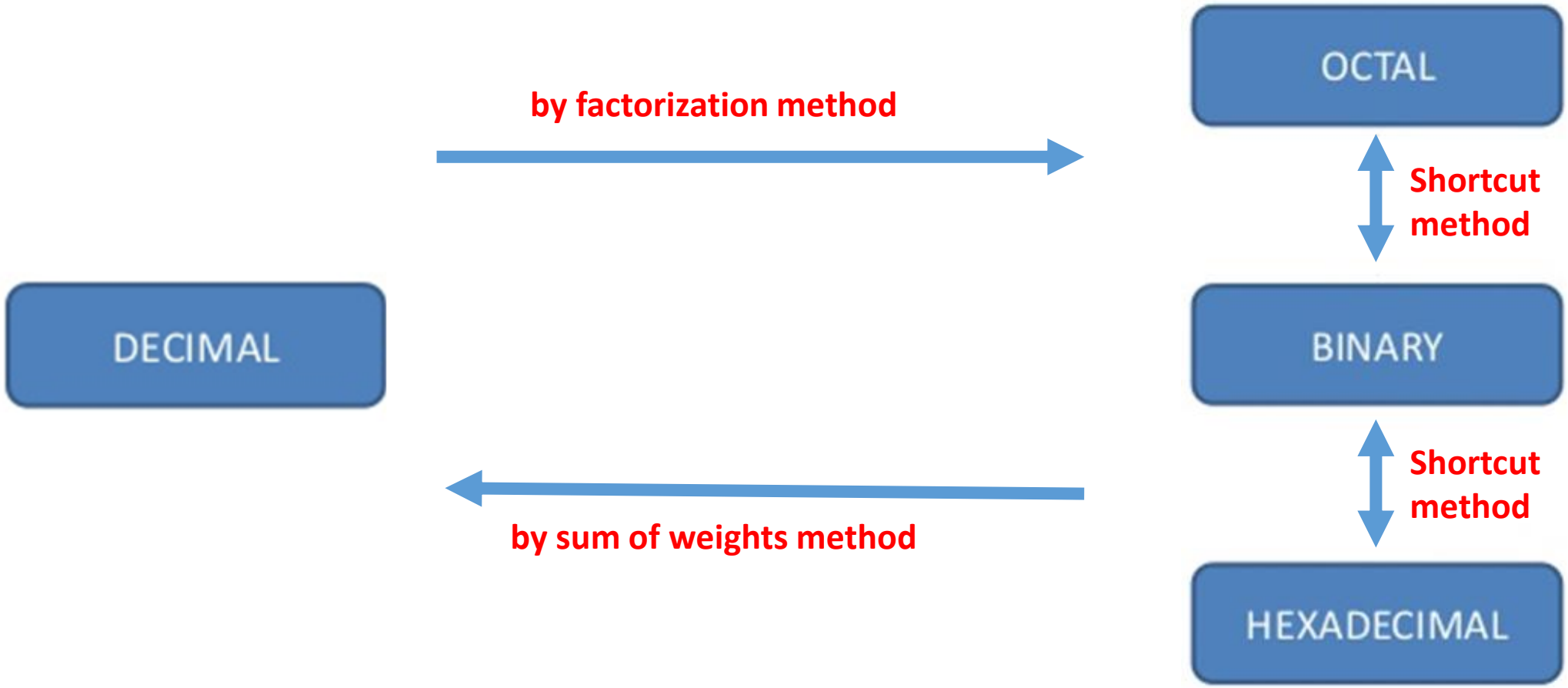
Course Outline

Digital Logic Design
Course Contents:
Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Methods (K-Map, Quinn Mc-Cluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines. Introduction Programmable Logic Devices (CPLD, FPGA); Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim
Reference Material:
1. Digital Fundamentals by Floyd, 11/e. 2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e.

Number Systems

	Most Significant				Least Significant	
6	5	4	3	2	1	← Places
100000	10000	1000	100	10	1	Decimal (10^n)
32	16	8	4	2	1	Binary (2^n)
3125	625	125	25	5	1	Five (5^n)
32768	4096	512	64	8	1	Octal (8^n)
1048576	65536	4096	256	16	1	Hexadecimal (16^n)

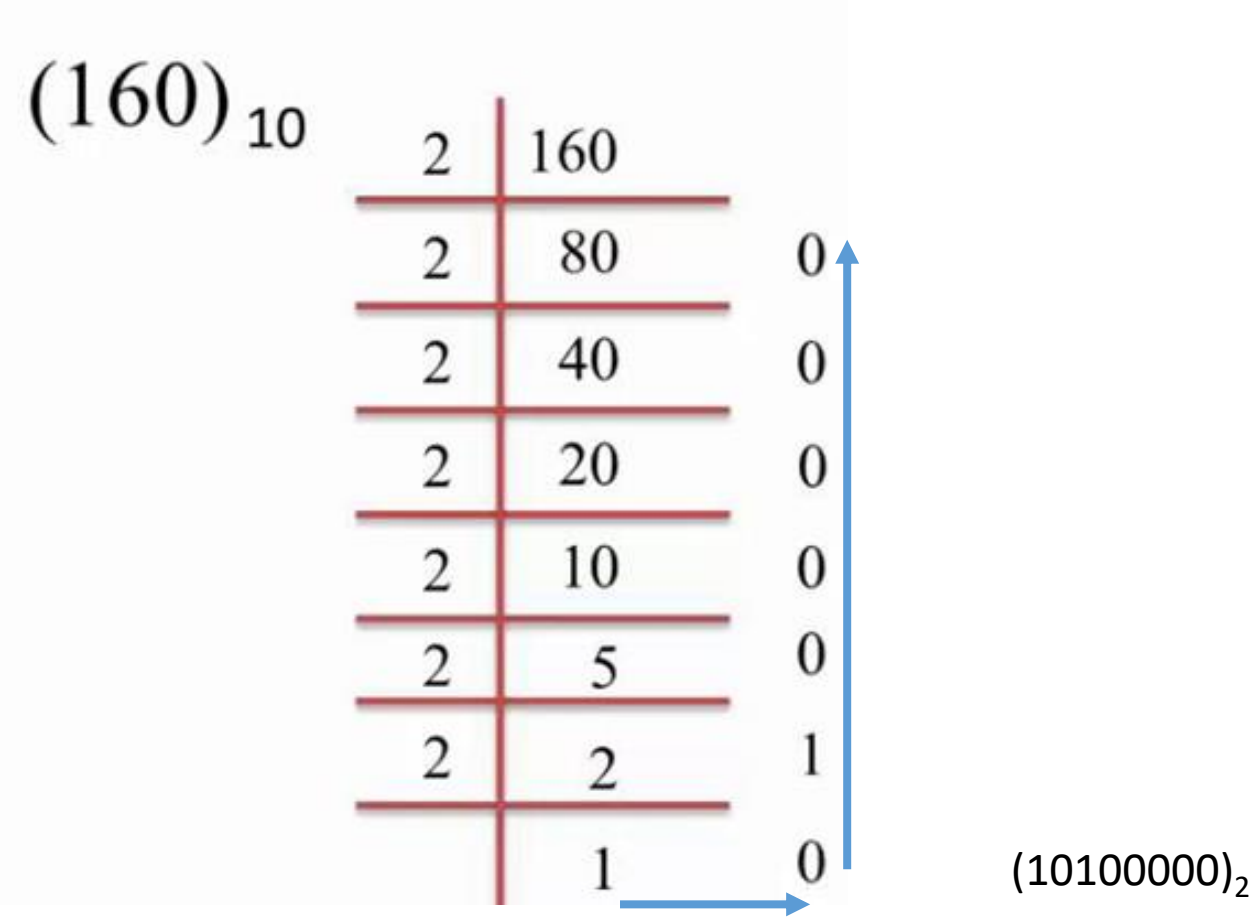
Number Systems cont...
Number System Conversions



Number Systems cont…

Conversion (Decimal to others – Factorization method)

$(160)_{10}$



$(10100000)_2$

Number Systems cont...

Conversion (Others to Decimal – Sum of Weights Method)

2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9
1	2	4	8	16	32	64	128	256	512

$$11011_2$$
$$= 2^4+2^3+0^2+2^1+2^0$$
$$= 16+8+0+2+1$$
$$= 27_{10}$$

$$10110101_2$$
$$= 2^7+0^6+2^5+2^4+0^3+2^2+0^1+2^0$$
$$= 128+0+32+16+0+4+0+1$$
$$= 181_{10}$$

Number Systems cont...

Conversion (Short cut method – Binary to Decimal)

10	9	8	7	6	5	4	3	2	1	Places/ Bits
512	256	128	64	32	16	8	4	2	1	Binary (2^n)

Number Systems cont...

Conversion (Short cut method – Binary to Decimal)

10	9	8	7	6	5	4	3	2	1	Places/ Bits
512	256	128	64	32	16	8	4	2	1	Binary (2^n)
			1	0	1	0	1	0	1	$(1010101)_2$

Number Systems cont...

Conversion (Short cut method – Binary to Decimal)

10	9	8	7	6	5	4	3	2	1	Places/ Bits
512	256	128	64	32	16	8	4	2	1	Binary (2^n)
		1	0	1	1	1	1	0	1	$(10111101)_2$

Number Systems cont...

Conversion (Short cut method – Binary to Decimal)

10	9	8	7	6	5	4	3	2	1	Places/ Bits
512	256	128	64	32	16	8	4	2	1	Binary (2^n)
1	0	1	0	1	1	1	1	0	1	$(1010111101)_2$

Number Systems cont...

Conversion (Short cut method – Binary to Decimal)

10	9	8	7	6	5	4	3	2	1	Places/ Bits
512	256	128	64	32	16	8	4	2	1	Binary (2^n)
	1	0	0	0	0	0	0	0	1	$(100000001)_2$

Number Systems cont...

Conversion (Short cut method – Binary to Decimal)

10	9	8	7	6	5	4	3	2	1	Places/ Bits	
512	256	128	64	32	16	8	4	2	1	Binary (2^n)	
			1	0	1	0	1	0	1	$(1010101)_2$	85
		1	0	1	1	1	1	0	1	$(10111101)_2$	189
1	0	1	0	1	1	1	1	0	1	$(1010111101)_2$	701
	1	0	0	0	0	0	0	0	1	$(100000001)_2$	257

Number Systems cont...

Conversion (Short cut method – Binary to Decimal)

10	9	8	7	6	5	4	3	2	1	Places/ Bits	
512	256	128	64	32	16	8	4	2	1	Binary (2^n)	
			1	0	1	0	1	0	1	$(1010101)_2$	85
		1	0	1	1	1	1	0	1	$(10111101)_2$	189
1	0	1	0	1	1	1	1	0	1	$(1010111101)_2$	701
	1	0	0	0	0	0	0	0	1	$(100000001)_2$	257

Number Systems cont...

Conversion (Short cut method – Decimal to Binary)

10	9	8	7	6	5	4	3	2	1	Places/ Bits
512	256	128	64	32	16	8	4	2	1	Binary (2^n)
										1000
										271
										990
										648
										777

Number Systems cont...

Conversion (Short cut method – Decimal to Binary)

10	9	8	7	6	5	4	3	2	1	Places/ Bits
512	256	128	64	32	16	8	4	2	1	Binary (2^n)
1	1	1	1	1	0	1	0	0	0	1000
0	1	0	0	0	0	1	1	1	1	271
1	1	1	1	0	1	1	1	1	0	990
1	0	1	0	0	0	1	0	0	0	648
1	1	0	0	0	0	1	0	0	1	777

Number Systems cont…

Conversion (Short cut method – Binary to Octal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(1\ 010\ 101)_2$

Number Systems cont…

Conversion (Short cut method – Binary to Octal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(1\ 010\ 101)_2$
								1	0	1	1	1	1	1	1	$(10\ 111\ 111)_2$

Number Systems cont…

Conversion (Short cut method – Binary to Octal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(1\ 010\ 101)_2$
								1	0	1	1	1	1	1	1	$(10\ 111\ 111)_2$
						1	0	1	0	1	1	1	1	1	0	$(1\ 010\ 111\ 110)_2$

Number Systems cont…

Conversion (Short cut method – Binary to Octal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(1\ 010\ 101)_2$
								1	0	1	1	1	1	1	1	$(10\ 111\ 111)_2$
						1	0	1	0	1	1	1	1	1	0	$(1\ 010\ 111\ 110)_2$
							1	0	0	0	0	0	0	0	1	$(100\ 000\ 001)_2$

Number Systems cont...

Conversion (Short cut method – Binary to Octal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(1\ 010\ 101)_2$
								1	0	1	1	1	1	1	1	$(10\ 111\ 111)_2$
						1	0	1	0	1	1	1	1	1	0	$(1\ 010\ 111\ 110)_2$
							1	0	0	0	0	0	0	0	1	$(100\ 000\ 001)_2$
			1	0	1	0	1	0	0	1	1	1	0	0	0	$(1\ 010\ 100\ 111\ 000)_2$

Number Systems cont...

Conversion (Short cut method – Binary to Octal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(1\ 010\ 101)_2$
								1	0	1	1	1	1	1	1	$(10\ 111\ 111)_2$
						1	0	1	0	1	1	1	1	1	0	$(1\ 010\ 111\ 110)_2$
							1	0	0	0	0	0	0	0	1	$(100\ 000\ 001)_2$
			1	0	1	0	1	0	0	1	1	1	0	0	0	$(1\ 010\ 100\ 111\ 000)_2$
	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	$(111\ 000\ 111\ 000\ 111)_2$

Number Systems cont…

Conversion (Short cut method – Binary to Octal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(1\ 010\ 101)_2$
								1	0	1	1	1	1	1	1	$(10\ 111\ 111)_2$
						1	0	1	0	1	1	1	1	1	0	$(1\ 010\ 111\ 110)_2$
							1	0	0	0	0	0	0	0	1	$(100\ 000\ 001)_2$
			1	0	1	0	1	0	0	1	1	1	0	0	0	$(1\ 010\ 100\ 111\ 000)_2$
	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	$(111\ 000\ 111\ 000\ 111)_2$
1	0	0	1	1	0	0	0	1	0	1	1	1	0	0	1	$(1\ 001\ 100\ 010\ 111\ 001)_2$

Number Systems cont…

Conversion (Short cut method – Binary to HexaDecimal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(101\ \ 0101)_2$

Number Systems cont...

Conversion (Short cut method – Binary to HexaDecimal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(101\ \ 0101)_2$
								1	0	1	1	1	1	1	1	$(1011\ \ 1111)_2$

Number Systems cont...

Conversion (Short cut method – Binary to HexaDecimal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(101\ \ 0101)_2$
								1	0	1	1	1	1	1	1	$(1011\ \ 1111)_2$
						1	0	1	0	1	1	1	1	1	0	$(10\ \ 1011\ \ 1110)_2$

Number Systems cont...

Conversion (Short cut method – Binary to HexaDecimal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(101\ \ 0101)_2$
								1	0	1	1	1	1	1	1	$(1011\ \ 1111)_2$
						1	0	1	0	1	1	1	1	1	0	$(10\ \ 1011\ \ 1110)_2$
							1	0	0	0	0	0	0	0	1	$(1\ \ 0000\ \ 0001)_2$

Number Systems cont...

Conversion (Short cut method – Binary to HexaDecimal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(101\ \ 0101)_2$
								1	0	1	1	1	1	1	1	$(1011\ \ 1111)_2$
						1	0	1	0	1	1	1	1	1	0	$(10\ \ 1011\ \ 1110)_2$
							1	0	0	0	0	0	0	0	1	$(1\ \ 0000\ \ 0001)_2$
			1	0	1	0	1	0	0	1	1	1	0	0	0	$(1\ \ 0101\ \ 0011\ \ 1000)_2$

Number Systems cont...

Conversion (Short cut method – Binary to HexaDecimal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(101\ \ 0101)_2$
								1	0	1	1	1	1	1	1	$(1011\ \ 1111)_2$
						1	0	1	0	1	1	1	1	1	0	$(10\ \ 1011\ \ 1110)_2$
							1	0	0	0	0	0	0	0	1	$(1\ \ 0000\ \ 0001)_2$
			1	0	1	0	1	0	0	1	1	1	0	0	0	$(1\ \ 0101\ \ 0011\ \ 1000)_2$
	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	$(111\ \ 0001\ \ 1100\ \ 0111)_2$

Number Systems cont...

Conversion (Short cut method – Binary to HexaDecimal)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Places/ Bits
									1	0	1	0	1	0	1	$(101\ \ 0101)_2$
								1	0	1	1	1	1	1	1	$(1011\ \ 1111)_2$
						1	0	1	0	1	1	1	1	1	0	$(10\ \ 1011\ \ 1110)_2$
							1	0	0	0	0	0	0	0	1	$(1\ \ 0000\ \ 0001)_2$
			1	0	1	0	1	0	0	1	1	1	0	0	0	$(1\ \ 0101\ \ 0011\ \ 1000)_2$
	1	1	1	0	0	0	1	1	1	0	0	0	1	1	1	$(111\ \ 0001\ \ 1100\ \ 0111)_2$
1	0	0	1	1	0	0	0	1	0	1	1	1	0	0	1	$(1001\ \ 1000\ \ 1011\ \ 1001)_2$

Number Systems cont...

Conversion (Short cut method – Octal to Binary)

1	4	2	1	4	2	1	4	2	1	4	2	1	4	2	1	weights
																$(727)_8$
																$(1234)_8$
																$(11111)_8$
																$(76543)_8$

Number Systems cont...

Conversion (Short cut method – Octal to Binary)

1	4	2	1	4	2	1	4	2	1	4	2	1	4	2	1	weights
							1	1	1	0	1	0	1	1	1	$(727)_8$
				0	0	1	0	1	0	0	1	1	1	0	0	$(1234)_8$
	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	$(11111)_8$
	1	1	1	1	1	0	1	0	1	1	0	0	0	1	1	$(76543)_8$

Number Systems cont…

Conversion (Short cut method – HexaDecimal to Binary)

8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1	Places/ Bits
																$(A01C)_{16}$
																$(A1C9)_{16}$
																$(F10D)_{16}$

Number Systems cont…

Conversion (Short cut method – HexaDecimal to Binary)

8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1	Places/ Bits
1	0	1	0	0	0	0	0	0	0	0	1	1	1	0	0	$(A01C)_{16}$
1	0	1	0	0	0	0	1	1	1	0	0	1	0	0	1	$(A1C9)_{16}$
1	1	1	1	0	0	0	1	0	0	0	0	1	1	0	1	$(F10D)_{16}$