# Digital Electronics Study Notes

**Number system**: the system used to count discrete units is called number system

**Decimal system:** the number system that contains 10 distinguished symbols that is 0-9 or digits is called decimal system. As per the number of symbols its base or radix is 10

**Binary number system:** the number system that contains only two distinguished symbols that is 0 and 1 is called binary number system. its base or radix is 2

**Hexadecimal number system:** the number system that contains 16 distinguished symbols that is 0-9 and A,B,C,D,E,F is called hexadecimal number system. It's base or radix is 16.

Conversion from binary number to decimal number is done as given below

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

Conversion from hexadecimal to decimal number is done as given below

$(A6B)_{16} = A \times 16^2 + 6 \times 16^1 + B \times 16^0$

$= 10 \times 256 + 6 \times 16 + 11 \times 1 = 2460 + 96 + 11 = 2667_{10}$

Conversion from decimal number to binary number is known as given below

| | |
|---|---|
| 2 | 25 |
| 2 | 12 |
| 2 | 6 |
| 2 | 3 |
| 2 | 1 |
| | 0 |

r = 1
r = 0
r = 0
r = 1
r = 1

LSB

MSB

$25_{10} = 11001_2$

Conversion from decimal number to hexadecimal number is done as shown below

| | |
|---|---|
| 16 | 2742 |
| 16 | 171 |
| 16 | 10 |
| | 0 |

r = 6
r = 11 =B
r = 10 = A

LSB

MSB

$2742_{10} = AB6_{16}$

**Binary coded decimal system:** it is another commonly used number system which is used in the field of digital electronics. in this case which digit of the decimal number is represented by 4 bit binary number example:

$359_{10}$= 0011 0101 1001 (BCD)
Where $3_{10}$ = $0011_2$ ; $5_{10}$ = $0101_2$ ; $9_{10}$ =$1001_2$ ;

**The ASCII code:** ASCII means American standard code for information interchange. is an alphanumeric code every numerals, letters and symbols of the board or printer is equipped with an ASCII code

**Logic Gates:** an electronic circuit which may have one, 2 or more input signals but only one output signal is called logic Gate
truth table: a tabular listing of all possible combination of inputs, for a logic Gate and the resultant output for each combination encoder truth table

**OR Gate:** it is logic Gate which has Low output when no input is high but the output is high when any or all inputs are high

**AND Gate:** it is logic Gate which is high output only when all the inputs are high what output is low when any are all the inputs are low.

**The Inverter or NOT GATE:** what is logic Gate which is higher output when the input is low and output is low when the input is high, this Gate has only one input

**NAND Gate:** it is logic Gate which is low output when all the inputs are high but output is high when any or all inputs are low.

**NOR Gate:** it is the logic Gate which has high output window input is high but the output is low when any or all inputs are high.

**Exclusive OR -XOR Gate:** It is a logic Gate which is higher output when both the inputs are identical that is either both are high for both are low

**Exclusive NOR -XNOR Gate:** it is a logic Gate which has high output when both the inputs are identical that is either both are high or both are low

**Boolean Algebra:** the mathematical operation by which various input variables, output variables and Boolean operations are interrelated.

Boolean equations a simplified by applying various theorems

**De Morgan's theorem:**

**First theorem:** it states that the component of a sum equals the product of the components.

That is $\overline{A + B} = \overline{A}.\overline{B}$

**Second theorem:** it states that complement of a product equals the sum of the components that is $\overline{AB} = \overline{A} + \overline{B}$

**Karnaugh map:** it is a method of simplifying Boolean functions or logic circuits a systematic mathematical way.

**Pair**: Karnaugh map that contains adjacent 1s horizontally or vertically is called pair.

**Quad**: when four adjacent 1s a grouped horizontally, vertically or in a square, the group so formed is called a quad

**Octet:** when 8 adjacent 1s are grouped horizontally or vertically, the group so formed is called an octet.

**Redundant groups:** group whose 1s are all overlapped by other groups is called redundant group

**NAND or NOR Universal gates:** these are called Universal Gates because this Gates can be used in place of all other Gates that is **NOT**, **AND**, **OR**, **XOR** etc

**Binary addition:** following rules are employed by adding binary numbers

0 + 0 equal to zero

0 + 1 equal to 1

1 + 0 equal to 1

1 + 1 equal to 10

1 + 1 + 1 equal to 11

**Half adder:** logic circuit which is used to add two binary bits is called a half adder. The output of the half adder is sum and carry. The Boolean expression and truth table of these outputs are:

Sum= $A \oplus B$

Carry = AB

| INPUTS | | OUTPUTS | |
|---|---|---|---|
| **A** | **B** | **SUM** | **CARRY** |
| **0** | **0** | **0** | **0** |
| **0** | **1** | **1** | **0** |
| **1** | **0** | **1** | **0** |
| **1** | **1** | **0** | **1** |

**Full adder:** a logic circuit which is used to add 3 binary bits is called a full adder. It has two outputs sum and carry. The Boolean expressions and truth table of these outputs are

Sum= $A \oplus B \oplus C$

Carry = $AB + AC + BC$

| INPUT | | | OUPUT | |
|---|---|---|---|---|
| **A** | **B** | **C** | **CARRY** | **SUM** |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 |

**Complete** binary adder: half adders and full adders are usually combined to add longer binary numbers.

**Encoder:** encoder is a device which converts the language of the people to the language of the machine

**Decoder:** Decoder converts the machine language to the people language

**Flip flop:** bistable multivibrator is also known as flip flop.

**Rs flip flop:** in Rs flip flop has two inputs namely reset and set accordingly it is known as Rs flip flop.

**Clocked the Rs flip flop:** to an Rs flip flop, when third input clock is added, the flip flop is known as clocked Rs flip flop.

**D flip flop:** in Rs flip flop which delays the Digital Signal by the duration of one clock cycle is called a D flip flop.

**Edge triggered D flip flop:** it is the most common type of D flip flop. it samples the bit or data at a unique instant.

**JK flip flop:** Universal flip flop, J and K are called control inputs because they determine what the flip flop does when a positive clock edge arrives.

**Register:** a group of memory elements that work together as a unit is called a resistor

**Buffer register:** buffer register is the simplest kind of register. it is used only to store a digital word.
Shift register: shift register is an array of flip flops design to store and shift the data.

Counters: counter is a register capable of counting the number of clock pulses that have arrived at its clock input.

**Ripple counter:** when the output of one flip flop drives another, we call the counter as a ripple counter or an asynchronous counter.