| binary (Keep adding 1 to get d next value) |
| --- |
| 000 |
| 001 |
| 010 |
| 011 |
| 100 |
| 101 |
| 110 |
| 111 |

(NB: You can remove the fust 2 0 cuz its not significant)

Friday 3rd September

CSC 217

Digital Systems

A **digital system** is a combination of devices designed to manipulate logical information or physical quantities that are represented in digital forms i.e the quantities can take only discrete values. This devices are most often electronics but they can also be mechanical magnetic or Pneumatics.

## Analog System

This is a system that contain devices that manipulates physical quantities that are represented in analog form. In an analog system, the quantities over a continuous range of values.

## Advantages of digital system

→ Digital system are easier to design.

* Information storag
* Accuracy and p to maximize th system.
* Operation can
* Digital Circu affected by nois
* More digital be fabricated

## Limitations of

* The real wo
* Processing d takes time.

## Voltage source Sour

A **voltage** So which can ~~pr~~ continuous fo electrons (or through the the two term device.

* Information storage is easy
* Accuracy and precision are easier to maximize throughout the system.
* Operation can be programmed.
* Digital circuits are less affected by noise.
* More digital circuitry can be fabricated on IC chips.

**Limitations of Digital systems**

* The real world is analog.
* Processing digital signals takes time.

## Voltage source and Current Source

A **voltage Source** is a device which can ~~produce~~ produce a continuous force to move electrons (or continuous voltage) through the wire connected to the two terminals of the device.

**Types of voltage Source**

* **Direct voltage Source**

This is a device which produces a continuous direct voltage output. A direct voltage is a type of voltage whose polarity remains the same. This type of voltage causes the current to move only in one direction continuosly. Examples of direct voltage source are cells, battery, DC generator.

**NOTE:** Polarity is defined as having two opposite electrical charges. "good" and "evil" are examples of polarity.

* **Alternating voltage Source**

This is a device which produces an alternating direct voltage output. Examples are A.C generator, DC to AC converter etc.

An alternating voltage is a type of voltage where polarity is reversed periodically. Alternating voltage causes the current to move in one direction for a period and then another direction for another period.

* Ideal Voltage Source

This is a kind of voltage source whose internal resistance is 0 such that the supply voltage does not change even if the external load resistance is changed.

## CURRENT SOURCE

This is a device which provides the regular flow of electrons or current on a circuit.

### Types of current Source

* Direct current Source

This is made of a direct voltage source.

* Alternating current Source

This is a type of current source made of an alternating voltage source.

* Ideal Current Source

This is a current source which provides a constant current without any relation with the voltage supplied to the ~~load~~ load.

Friday 10th Sep.

## CURRENT, VOLTAGE, RESISTANCE AND OHMS LAW

### Current

Current is the rate at which electric charge flows past a point in a circuit. In other words, it is the rate of flow of electric charge.

$$C = \frac{E}{T} \qquad \text{i.e.} \quad \boxed{I = \frac{Q}{T}}$$

Current can be measured in ampheres or coloumbs per sec.

### Voltage

Voltage also called electromotive force is the potential difference in charge between two points in an electrical field. It is measured in volt.

Relationship between current & voltage

1. Current is the effect and voltage being the cause
2. Current cannot flow without voltage.
3. Voltage can exist without current.

Comparison

| Current | Voltage |
| --- | --- |
| 1.) It is the same through all components connected in series | Voltage gets distributed over components connected in series. |
| 2.) It gets distributed over components connected in parallel. | Voltage are the same across all components in parallel. |

## RESISTANCE

This is a property of a conductor by virtue of which the passage of current is opposed forcing electric energy to be transformed.

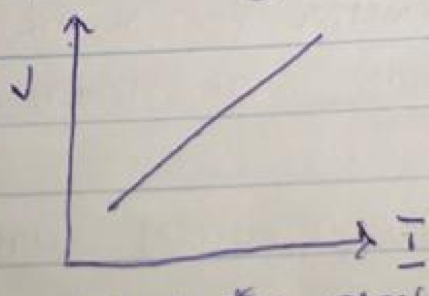
OHMS LAW

This states that the current through a conductor between two point is directly proportional to the voltage across the two points.

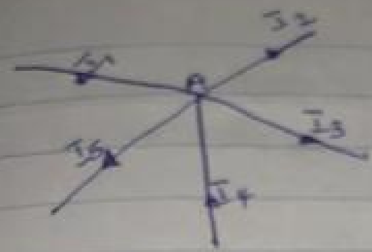
$$V \propto I$$

$$V = IR$$

The constant of proportionality is resistance represented by




This law states that the algebraic sum of current in a junction or node is 0. It simply means that the total current leaving a junction is equal to the total current entering the junction.




$$I_1 + I_4 - I_2 - I_5 - I_3 = 0$$
$$I_1 + I_4 = I_2 + I_5 + I_3$$
$$\Sigma I = 0$$

## Kirchoff's voltage Law

This state that the algebraic sum of the product of current and resistance in each of the conductors in any closed path. In a newton the algebraic sum of the emf in that path is Zero.

$$\Sigma IR + \Sigma emf = 0$$

## Superposition Theorem

This states that in a newton of linear resistance containing more than one source of emf, the current which flows at any point is the sum of all the current which will flow at that point if each emf is considered separately and all the others emf replaced for the time being by resistances equal to their interval resistances.

OR

The current has in a branch of a linear circuit is equal to the sum of the current produced by each source with the other sources set equal to zero.

~~Thevenin~~ Therein

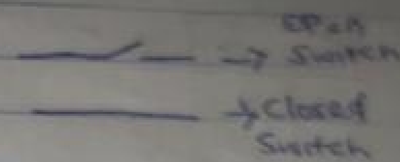
Thevenin theorem

This state that any linear two terminal DC network can be represented by a voltage source in series with a resistance

## Boolean Constant and variable.

Boolean algebra differ in a major way from normal algebra because boolean constants and variables are allowed to have only two possible values 0s or 1. A boolean variable is a quantity that ~~may~~ at different times, it is either equal to 0 or 1. Boolean 0 and 1 do not represent actual numbers but instead represent the stage of a voltage variable or what is called its logic level. A voltage in a digital circuit is said to be at the logic 0 level or the logic 1 level depending on its actual numeric value. In a digital logic, several other terms are used synnonimosly are shown in the table below

| Logic 0 | Logic 1. |
|---|---|
| False | True |
| Off | On |
| Low | High |
| No | Yes |
| Open Switch | closed switch |




Boolean algebra is a means of expressing the relationship between a logic circuit input and output. The inputs are considered logic variables whose logic levels at any time determine the output level because only two values are possible, Boolean algebra is relatively easy to work it compared with ordinary algebra. In boolean algebra, there are no fractions, decimal, negative numbers, square roots, cube roots, logarithms, immaginary numbers, and so on. In fact, in boolean algebra, there are only 3 basic operations: **OR**, **AND**, and **NOT.**

Truth Tables

A Truth table is a means for describing how a logic circuit output depends on the logic level present at the circuit input.

NB: For a two input table, there are 4 entries.
For a 3 input table, there are 8 table entries.
For a 4 input table, there are 16 table entries.

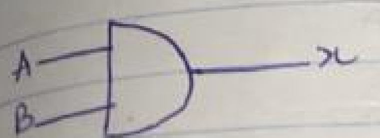
The Number of input combinations will equal $2^n$ for an N input truth tables.

## AND operation with AND Gate

$x = A \cdot B$

| A | B | x |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

$x = 0 \times 0 = 0$
$= 0 \times 1 = 0$
$= 1 \times 0 = 0$
$= 1 \times 1 = 1$

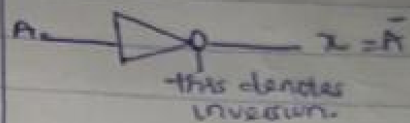



$x = A \cdot B$

## NOT Gate.

The NOT operation is unlike OR and AND operations because it can be perform on a single input variable. For example, if variable A is subjected to the NOT operation, the output X can be expressed as follows

$x = \bar{A}$




i.e its denotes the inverse

## BOOLEAN THEOREMS

1.) $x \cdot 0 = 0$
2.) $x \cdot 1 = x$
3.) $x \cdot x = x$
4.) $x \bar{x} = 0$
5.) $x + 0 = x$
6.) $x + 1 = 1$
7.) $x + x = x$
8.) $x + \bar{x} = 1$
9.) $x + y = y + x$
10.) $x \cdot y = y \cdot x$
11) $x + (y+z) = (x+y) + z = x + y + z$
12) $x(yz) = (xy)z = xyz$
13)a) $x(y+z) = xy + xz$
13b) $(w+x)(y+z) = wy + xy + wz + xz$
14) $x + xy = x$
15a) $x + \bar{x}y = x + y$
15b) $\bar{x} + xy = \bar{x} + y$

OR

Examples (input → X, Y; Z ← output)

| X | Y | Z |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

OR

| A | B | C | Z |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

17/09/2021. $\boxed{\text{OR operation with OR Gate.}}$

$x = A+B$

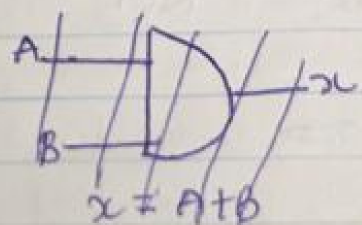
| A | B | x |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | |

$x = 0+0 = 0$

$= 0+1 = 1$

$= 1+0 = 1$

$= 1+1 = 1$


$\boxed{\text{OR gate}}$

AND operat...

$x = A$...

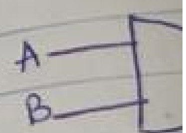
| A | B | x... |
|---|---|---|
| 0 | 0 | ... |
| 0 | 1 | ... |
| 1 | 0 | ... |
| 1 | 1 | ... |

$x = 0 \times 0 =$ ...

$= 0 \times 1$ ...

$= 1 \times 0$ ...

$= 1 \times 1$ ...




$x =$ ...

NOT ...

The NO...
OR and ...
it can b...
input va...
variable ...
NOT op...
be exp...

De morgan's theorem

(6a) $\overline{x+y} = \bar{x}\cdot\bar{y}$

(6b) $\overline{x\cdot y} = \bar{x}+\bar{y}$

Exercises

1) Simplify the expression

$y = A\bar{B}D + A\bar{B}\bar{D}$

Solution.

$y = A\bar{B}D + A\bar{B}\bar{D}$

$= A\bar{B}(\underbrace{D+\bar{D}}_{1})$

$A\bar{B}(1) = A\bar{B}$

2) Simplify $Z=(\bar{A}+B)(A+B)$

Solution

$Z=(\bar{A}+B)(A+B)$

$=\bar{A}A+\bar{A}B+BA+B$

$=0+\bar{A}B+BA+B$

$=\bar{A}B+BA+B$

$=B(\bar{A}+A+1)$

$=B(1+1)$

$=B(1)$

$=B$

Under de morgan's theorem,

3.) Simplify

$x = ACD+\bar{A}BCD$

$=CD(A+\bar{A}B)$

$=CD(A+B)$

$=ACD+BCD$

$\boxed{\text{RESISTIVITY}}$

$R \propto \frac{L}{A}$

$R = \underset{\text{resistivity}}{\rho}\,\frac{L}{A}$

$\rho = \frac{R\cdot A}{L}$ $(\Omega m)$

$\underset{\text{mass}}{M}\underset{\text{length}}{L}\underset{\text{time}}{\bar{T}}$

Question

A coil consists of 2,000 turns of copper wire having a cross sectional area of $0.8mm^2$. The mean length per turn is 80cm and the resistivity of copper is convert 0.8mm to cm

0.02microohm meter.

0.02 $\mu\Omega$m ~~microohm meter~~ find the resistance of the coil and power absorbed by the coil when connected across 110v dc supply.

Solution.

Length of the coil $(L) = 80 \times 2000cm$

$= 160000cm$

But $100cm = 1m$

$\therefore L = 160\,000cm = 1600\,m$

Area $= 0.8mm^2$

$\boxed{mm = 10^{-3}m \quad 1mm^2 = 10^{-6}m^2}$

Area $= 0.8 \times 10^{-6} m^2$

Resistivity $(\rho) = 0.02\mu\Omega m = 0.02 \times 10^{-6}\Omega m$

$$\boxed{\cancel{R = \rho \cdot \frac{L}{A} = \frac{0.02 \times 1600}{0.8 \times 10^{-6}} =}\ \text{Mistake}}$$

$$R = \rho \cdot \frac{l}{A} = \frac{0.02 \times 10^{-6} \times 1600}{0.8 \times 10^{-6}}$$

$$= \frac{0.02 \times 10^{-6} \times 1600 \times 10^{6}}{0.8}$$

$$\cancel{= 40 \times 10^{4}\Omega}$$

$$= \frac{0.02 \times 1600}{0.8} = 40\Omega$$

$$\text{Power } (P) = \frac{V^2}{R}$$

$V = 110v$

$$P = \frac{(110)^2}{40} = \frac{12100}{40}$$

$$= 302.5W.$$

Friday 24th Sep. 2021.

## Designing combinational logic circuits.

When the desired output level of a logic circuit is given for all possible input conditions, the results can be conveniently displaced in a truth table. The boolean expression for the required ~~output~~ circuit can then be derived from the truth table. The following are the complete design procedure for a combinational logic circuit. Examples

Design a logic circuit that has 3 inputs A, B and C, and whose output will be ~~I~~ high (HIGH) only when the majority of the inputs ~~will be~~ are high.

**Solution**

**STEP 1:** Set up the truth table.

| Inputs | | | Output |
| --- | --- | --- | --- |
| A | B | C | $x$ |
| 0 | 0 | 0 | |
| 0 | 0 | 1 | |
| 0 | 1 | 0 | |
| 0 | 1 | 1 | $\leftarrow \bar{A}BC$ |
| 1 | 0 | 0 | |
| 1 | 0 | 1 | $\leftarrow A\bar{B}C$ |
| 1 | 1 | 0 | $\leftarrow AB\bar{C}$ |
| 1 | 1 | 1 | $\leftarrow ABC$ |

NB: outputs will be HIGH when the majority of the INPUTS are high. i.e where 1 is more than 0 i.e 4 times.

NB: The $(^{-})$ Bar shows the value is 0

**Step 2:** Write the AND term for each case where the output is 1

NB: There are 4 such cases and they are shown in the truth tables i.e $\bar{A}BC$, $A\bar{B}C$, $AB\bar{C}$ and $ABC$.

**Step 3:** Write the sum of product expression for the outputs.

i.e

$x = \bar{A}BC, A\bar{B}C, AB\bar{C} + ABC$

**Step 4:** Simplify the output expression

The expression can be simplified in several ways. Perhaps, the quickest way is to realise that the last term ABC has two variables in common with each of the other terms. We can use ABC term to factor each of the other terms. The expression is rewritten with the ABC term occuring 3 times.

**Step 4:**

$x = \bar{A}BC + ABC + A\bar{B}C + ABC + AB\bar{C} + ABC$

Solve using Boolean theorem.

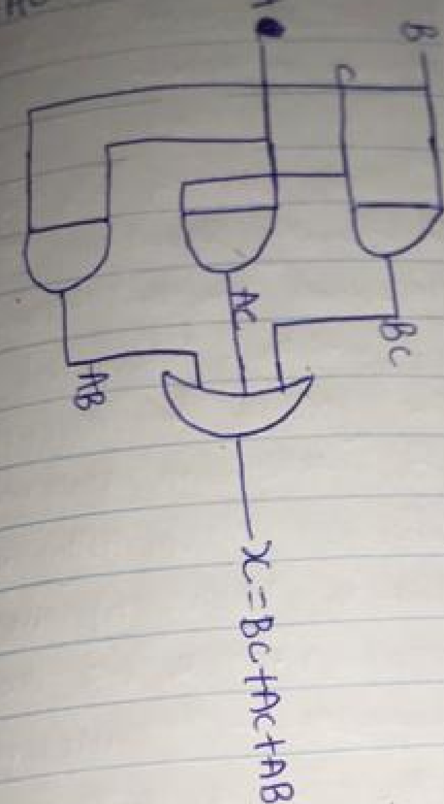
$= BC(\bar{A}+A) + AC(\bar{B}+B) + AB(\bar{C}+C)$

But, $\bar{A}+A$, $\bar{B}+B$ and $\bar{C}+C = 1$

$\therefore x = BC + AC + AB$

**Step 5:** Implement the circuit for the final expression

$x = BC + AC + AB$




New topic:

## INTEGRATED CIRCUIT(IC)

An IC is a complex electronic circuit in which both the active and persive component are fabricated on a tiny single chip of silicon.

Active components are those which have the capability to produce gain. Examples are transistors and field effect transistors (FET).

Passive components or devices are those which do not have this ability. Examples are resistors, capacitors, and inductors.

### Advantages of IC

1.) Extremely small physical size.

2.) Very small weight.

3.) Reduced cost.

4.) Extremely high reliability: This is due to many factors;

a.) Absence of Soldered connections

b.) Need for fewer Interconnections which is major cause of circuit failures.

c.) Small temperature rise due to low power consumptions of ICs

NOTE: Higher reliability means that ICs will work for longer period without giving any troubles.

5.) Increased response time and speed.

6.) low power consumption.

7.) Easy replacement.

8.) Higher yield

Drawbacks (Disadvantages) of ICs

1.) Coils or inductors cannot be fabricated

2.) ICs functions at fairly low voltages

3.) They handle only limited amount of power

4.) They are quite delicate and cannot withstand rough handly or excessive heat.

Scale of Integration

1.) SSI : Small scale Integration; The number of circuits obtained in one IC package is less than 10.

2.) MSI : Medium Scale Integration The number of circuits per IC Package is between 13 and 99.

3.) LSI : Large Scale integration The no of circuits per IC package is 100 and 9,999.

4.) VLSI (Very large scale Integration) Their number of circuit per package is between 10,000 and 99,999.

5.) Ultra large Scale Integration (ULSI) : The circuit density is between 100,000 and 999,999.

6.) Giga scale integration (GSI) : The number of circuit per package is million or more.

Classification of ICs by structure

Structurally Speaking, IC's can be classified into the following,

1.) Monolithic Integrated circuit : In this type of IC all circuit component both active and passive are fabricated insperably within a single piece of silicon crystalline material called WAFER OR SUBTRATE. All Components are automatically part of the same chip.

2.) Thick and thin film ICs : Thick thin IC's are Constructed by depositing films of conducting Materials Through a mask on the Subtrate made of glass & Ceramics.

Thick film IC's : This type of IC's, Silk screen printing technique are used to create desired pattern

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Thick film IC's : This type of IC's, Silk screen printing technique are used to create desired pattern on the Surface of the Ic's.

3.) Hybrid Ic's. These are formed either by interconnecting a number of individual chips or by a combination of film and monolithic Ic's techniques.

Classification of Ic's by function
① Linear Ic's
② Digital Ic's

Linear Integrated Circuits: Also referred to as analogue Ic's because their inputs and outputs can take on a continuous range of values and the outputs are generally proportional to the input as combined to digital Ic's.

a.) Linear
b.) They possess higher reliability because so many external connections are eliminated. They are frequently used in;
i) operational amplifiers
(ii) Small signal amplifiers
iii) Power amplifiers
iv) RF and IF amplifiers
v) Microwave amplifiers
vi) Multipliers
vii) Voltage comparators
viii) Voltage regulators.

Digital Integrated circuits: These are mostly used by the Computer Industry. They lend themselves easily to monolithic integration because a computer uses a large number of identical circuits.
Digital Ic's contains circuits whose input and output voltages are limited to two possible values, Low or high. This is because digital signals are usually binary.
Digital Ic's include circuits such as;
(i.) Logic gate
(ii.) flip floops
(iii.) Counters
(iv.) Clock-chips

v) calculator chips
vi) Memory chips
vii) Microprocessor.

Friday. 15/oct/2021

## Semi conductors.

A semi conductor material is one whose electrical properties lies btw those of insulators and conductors eg silicon and germanium. In terms of energy bands, semi conductors can be defined as "ie" those materials which have almost an empty conduction band and almost filled valence band with a very narrow energy gap separating the two. Semi conductor current is the sum of electron and hole currents flowing in opposite directions.

Types of semi conductors.

Semi conductors can be classified as shown below;-

- Semi conductors
  - Intrinsic or pure semiconductors
  - Extrinsic or impure semi conductors.
    - N-Type
    - P-type

Intrinsic or pure semiconductors

An Intrinsic semiconductor is one which is made up of a semi conductor material in its extremely pure form. ~~Alternatively~~ Alternatively, an intrinsic semiconductors may be define as one in which the no of conduction electron is equal to the no of holes. Examples of such semi conductors are pure gamanium and silicon which have forbidden energy gaps of 0.72eV and 1.1eV respectively.

The energy gap is so small that even at ordinary room temperature, there are many electrons which ~~possess~~ process sufficient energy

However, it is worth noting that for each electron liberated into the conduction band, a positively charged hole is created in the valence band.

2.) Extrinsic Semiconductors

Those intrinsic semiconductors ~~t~~ to which some impurities or ~~dopant~~ doping agent or dopant has been added in extremely small amounts are called extrinsic or impure semi conductors. The usual doping agents are;

a.) pentavalent atoms having 5 valence electrons (Arsenic, Antimony, phosphorous) or

b.) Trivalent atoms having 3 valence electrons (gallium, aluminium, boron

Depending on the type of doping material used, extrinsic semi conductors can be subdivided into (2) classes;

(i) N type Semi conductors

(ii) P type semi conductor

(i) N type

This type of Semi conductor is obtained when a pentavalent material like anthimony is added to pure germanium crystal. In N type semi conductors, electrons are the majority carriers while holes constitute the minority carrier. Hence, N type semi conductors conduct principally by electrons in the nearly ~~electron~~ empty conduction band and the process is called excess conduction.

the short term scheduling is only called whenever an event occurs that

11.) p type Semi conductors

This type of Semi conductor is obtained when traces of trivalent material are added to a pure gamanium crystal. In this case, the three valence electron of boron atom form covalent bond with four surrounding atoms and one bond is left incomplete and gives rise to a whole holes form majority negative carriers while ~~the~~ electrons constitute minority positive carrier