# NEAR EAST UNIVERSITY

## Faculty of Engineering

## Department of Electrical and Electronic Engineering

# ELECTRIC INSTALLATION OF STUDENT DORMITORY

## Graduation Project
## EE – 400

**Student: M.Buğra Türköz(20031289)**

**Supervisor:Assoc. Prof. Dr. Kadri Bürüncük**

NICOSIA 2008

## ACKNOWLEDGMENTS

First I want to thank Assoc. Prof. Dr. Kadri Bürüncük to be my supervisor. under his guidance, I succesfully overcome many difficulties and léarn a lot about Installation project. In each discussion,he explained my questions patiently, and I felt my quick progress from his advises . He always helps me a lot either in my study or my life. I asked him many questions in illumination calculations and selction of fuses etc.and he always answered my questions quickly and in detail.

Special thanks mrs özgür özerdem.I learned so much things at his illumination lecture about my projects that informations became very useful for me at my insatllation project.and also thanks for helps of mrs cemal kavalcioglu

Finally, I want to thank my family, especially my parents.Without their endless support and love for me, I would never achieve my cuurent position. I wish my mother lives happily always, and my father in the heaven be proud of me.

## ABSTRACT

Illumination and electrical distribution can only be achieved if there is a proper electrical installation. As a well-designed installation plan makes all levels of illumination and electrical distribution possible, process of installation from the beginning to the end plays a vital role in making illumination possible.

This report consists of illumination and electrical distribution of a special student dormitory.

Firstly, architectural plan containing detailed dimensional measurements of all parts of the dormitory building in the form of AutoCAD Drawing Software Programme is obtained for constructing the installation plan.

Lastly, mathematical calculations using *K-Factor Method* for the adjustment of the illumination levels of the building and electrical distribution including proper cable and fuse selection and proper positioning the sockets – *electrical sockets, TV and telephone sockets* according to the requirements of the dormitory students and personel is carried out.

# TABLE OF CONTENTS

# INTRODUCTION

In this Project subjects are explained at below briefly, you can see process of installation Project step by step and information about parts of installation

Chapter-1 Tells history of electricity how did it invented invented by who and also theories aether

Chapter-2 about safety circuits and components something explained about fuses and their utility and also types of fuses and their materials where they use also fuse boxes and some photos about fuses

Chapter-3 Presents types of circuits at installation started with socket circuits ring circuit and radial circuit and also you can find so many informations about contats

Chapter-4 inculudes information about cables cable types,section are of cables and their properties and their usage places

Chapter-5 is earthing it tells how does eartihing makes and what is advantages of earthing

Chapter-6 you can see the illumination calculations of this Project with details

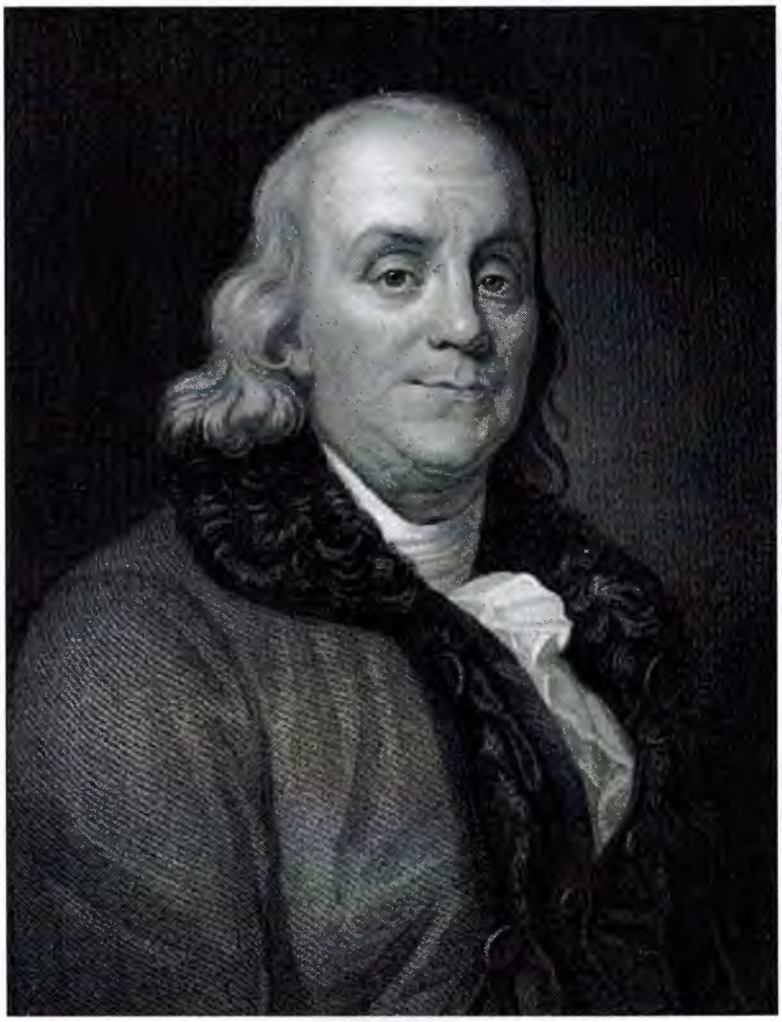
# CHAPTER ONE

# HISTORY OF ELECTRICITY

## 1.1 A History Of The Theories Of Aether And Electricity

### 1.1.1 Benjamin Fraklin

Franklin was an American writer, publisher, scientist and diplomat, who helped to draw up the famous Declaration of Independence and the US Constitution. In 1752 Franklin proved that lightning and the spark from amber were one and the same thing. The story of this famous milestone is a familiar one, in which Franklin fastened an iron spike to a silken kite, which he flew during a thunderstorm, while holding the end of the kite string by an iron key. When lightening flashed, a tiny spark jumped from the key to his wrist. The experiment proved Franklin's theory, but was extremely dangerous - He could easily have been killed.



**Benjamin Fraklin**

### 1.1.2. Galvani And Volta

In 1786, Luigi Galvani, an Italian professor of medicine, found that when the leg of a dead frog was touched by a metal knife, the leg twitched violently. Galvani thought that the muscles of the frog must contain electricity. By 1792 another Italian scientist, Alessandro Volta, disagreed: he realised that the main factors in Galvani's discovery were the two different metals - the steel knife and the tin plate - apon which the frog was lying. Volta showed that when moisture comes between two different metals, electricity is created. This led him to invent the first electric battery, the voltaic pile, which he made from thin sheets of copper and zinc separated by moist pasteboard.

**Alessandro Volta**

In this way, a new kind of electricity was discovered, electricity that flowed steadily like a current of water instead of discharging itself in a single spark or shock. Volta showed that electricity could be made to travel from one place to another by wire, thereby making an important contribution to the science of electricity. The unit of electrical potential, the Volt, is named after Volta.

### 1.1.3 Michael Faraday

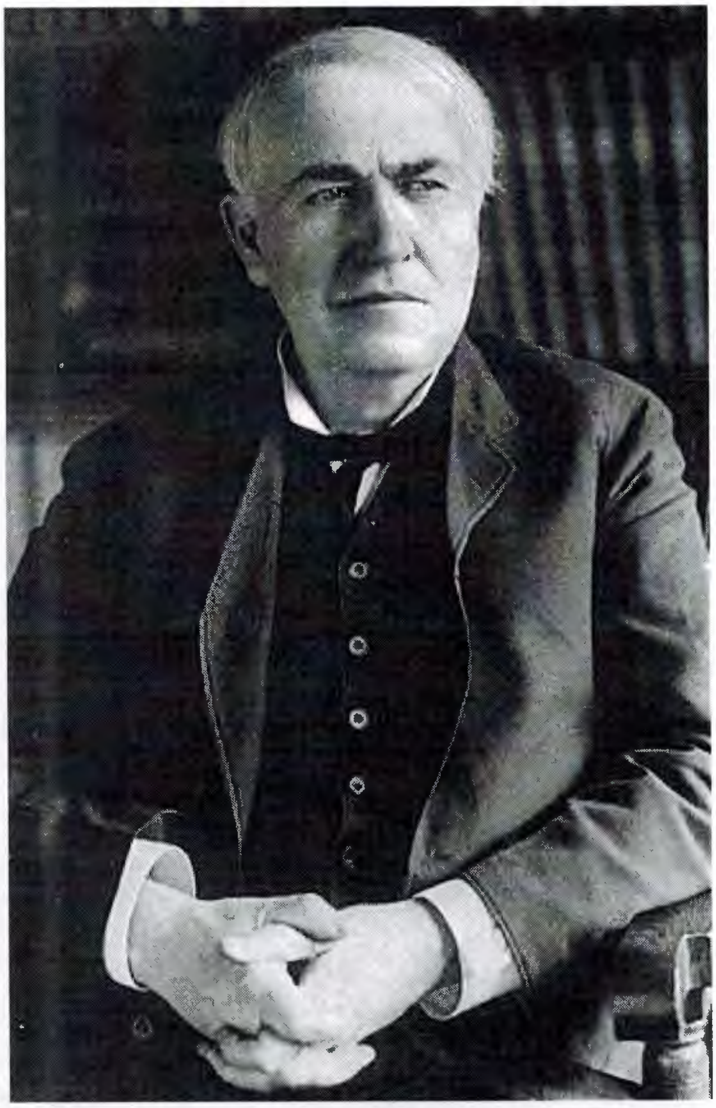
The credit for generating electric current on a practical scale goes to the famous English scientist, Michael Faraday. Faraday was greatly interested in the invention of the electromagnet, but his brilliant mind took earlier experiments still further. If electricity could produce magnetism, why couldn't magnetism produce electricity.

**Michael Faraday**

In 1831, Faraday found the solution. Electricity could be produced through magnetism by motion. He discovered that when a magnet was moved inside a coil of copper wire, a tiny electric current flows through the wire. Of course, by today's standards, Faraday's electric dynamo or electric generator was crude, and provided only a small electric current be he discovered the first method of generating electricity by means of motion in a magnetic field.

### 1.1.4 Thomas Edison And Joseph Swan

Nearly 40 years went by before a really practical DC (Direct Current) generator was built by Thomas Edison in America. Edison's many inventions included the phonograph and an improved printing telegraph. In 1878 Joseph Swan, a British scientist, invented the incandescent filament lamp and within twelve months Edison made a similar discovery in America.



**Thomas Edison**

Swan and Edison later set up a joint company to produce the first practical filament lamp. Prior to this, electric lighting had been my crude arc lamps.

Edison used his DC generator to provide electricity to light his laboratory and later to illuminate the first New York street to be lit by electric lamps, in September 1882. Edison's successes were not without controversy, however - although he was convinced of the merits of DC for generating electricity, other scientists in Europe and America recognised that DC brought major disadvantages.

### 1.1.5 George Westinghouse And Nicola Tesla

Westinghouse was a famous American inventor and industrialist who purchased and developed Nikola Tesla's patented motor for generating alternating current. The work of Westinghouse, Tesla and others gradually persuaded American society that the future lay with AC rather than DC (Adoption of AC generation enabled the transmission of large blocks of electrical, power using higher voltages via transformers, which would have been impossible otherwise). Today the unit of measurement for magnetic fields commemorates Tesla's name.

**Nicola Tesla**

### 1.1.6 James Watt

When Edison's generator was coupled with Watt's steam engine, large scale electricity generation became a practical proposition. James Watt, the Scottish inventor of the steam condensing engine, was born in 1736. His improvements to steam engines were patented over a period of 15 years, starting in 1769 and his name was given to the electric unit of power, the Watt.

**James Watt**

Watt's engines used the reciprocating piston, however, today's thermal power stations use steam turbines, following the Rankine cycle, worked out by another famous Scottish engineer, William J.M Rankine, in 1859.

### 1.1.7 Andre Ampere And George Ohm

Andre Marie Ampere, a French mathematician who devoted himself to the study of electricity and magnetism, was the first to explain the electro-dynamic theory. A permanent memorial to Ampere is the use of his name for the unit of electric current.

**Andre Ampere**

George Simon Ohm, a German mathematician and physicist, was a college teacher in Cologne when in 1827 he published, "The galvanic Circuit Investigated Mathematically". His theories were coldly received by German scientists but his research was recognised in Britain and he was awarded the Copley Medal in 1841. His name has been given to the unit of electrical resistance.

### 1.1.8 History of electricity

Depite what you have learned, Benjamin Franklin did not "invent" electricity. In fact, electricity did not begin when Benjamin Franklin at when he flew his kite during a thunderstorm or when light bulbs were installed in houses all around the world.

The truth is that electricity has always been around because it naturally exists in the world. Lightning, for instance, is simply a flow of electrons between the ground and the clouds. When you touch something and get a shock, that is really static electricity moving toward you.

Hence, electrical equipment like motors, light bulbs, and batteries aren't needed for electricity to exist. They are just creative inventions designed to harness and use electricity.

The first discoveries of electricity were made back in ancient Greece. Greek philosophers discovered that when amber is rubbed against cloth, lightweight objects will stick to it. This is the basis of static electricity.

Over the centuries, there have been many discoveries made about electricity. We've all heard of famous people like Benjamin Franklin and Thomas Edison, but there have been many other inventors throughout history that were each a part in the development of electricity.

# CHAPTER TWO

# SAFETY CIRCUITS AND COMPONENTS

In safety circuits components there are so many components such as fuses,circuit breakers,overcurrent relays but in my project ı will give you informations about fuses

## 2.1 Fuse

In electronics and electrical engineering a **fuse** is a type of overcurrent protection device. Its essential component is a metal wire or strip that melts when too much current flows, which breaks the circuit in which it is connected, thus protecting the circuit's other components from damage due to excessive current.


A practical fuse was one of the essential features of Thomas Edison's electrical power distribution system. An early fuse was said to have successfully protected an Edison installation from tampering by a rival gas-lighting concern.

Fuses (and other overcurrent devices) are an essential part of a power distribution system to prevent fire or damage. When too much current flows through a wire, it may overheat and be damaged, or even start a fire. Wiring regulations give the maximum rating of a fuse for protection of a particular circuit. Local authorities will incorporate national wiring regulations as part of law. Fuses are selected to allow passage of normal currents, but to quickly interrupt a short circuit or overload condition.

## 2.2 Characteristic Parameters

- **Rated current $I_N$:** This is the maximum current that the fuse can continuously pass without interruption to the circuit, or harmful effects on its surroundings.

- **The $I^2t$ value:** This is a measure of the energy required to blow the fuse element and is an important characteristic of the fuse. It is an indication of the "let-through" energy passed by the fuse which downstream circuit elements must withstand before the fuse opens the circuit.

- **Voltage drop:** The values of the voltage drop across a fuse are usually given by the manufacturer. A fuse may become hot due to the energy dissipation in the fuse element at rated current conditions. The voltage drop should be taken into account particularly when using a fuse in low-voltage applications.

- **Breaking capacity:** The breaking capacity is the maximum current that can safely be interrupted by the fuse. Some fuses are designated High Rupture Capacity (HRC) and are usually filled with sand or a similar material.

- **Voltage rating:** The voltage rating of a fuse should always be greater than or equal to the circuit voltage. Low-voltage fuses can generally be used at any voltage up to their rating. Some medium-voltage and high-voltage fuses used in electric power distribution will not function properly at lower voltages.

The speed at which a fuse operates depends on how much current flows through it and the material of which the fuse is made. In addition, temperature influences the resistance of the fuse. Manufacturers of fuses plot a time-current characteristic curve, which shows the time required to melt the fuse and the time required to clear the circuit for any given level of overload current.

Where several fuses are connected in series at the various levels of a power distribution system, it is very desirable to clear only the fuse (or other overcurrent devices) electrically closest to the fault. This process is called "coordination" and may require the time-current characteristics of two fuses to be plotted on a common current basis. Fuses are then selected so that the minor, branch, fuse clears its circuit well before the supplying, major, fuse starts to melt. In this way only the faulty circuits are interrupted and minimal disturbance occurs to other circuits fed by the supplying fuse.

Where the fuses in a system are of similar types, simple rule-of-thumb ratios between ratings of the fuse closest to the load and the next fuse towards the source can be used.

Fuses are often characterized as "fast-blow", "slow-blow" or "time-delay", according to the time they take to respond to an overcurrent condition. The selection of the characteristic depends on what equipment is being protected. Semiconductor devices may need a fast or *ultrafast* fuse for protection since semiconductors may have little capacity to withstand even a momentary overload. Fuses applied on motor circuits may have a time-delay characteristic, since the surge of current required at motor start soon decreases and is harmless to wiring and the motor.

## 2.3 Interrupting Rating

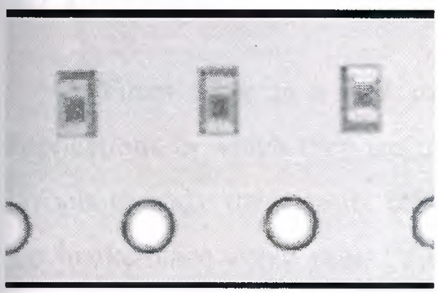
A fuse also has a rated interrupting capacity, also called breaking capacity, which is the maximum current the fuse can safely interrupt. Generally this should be higher than the maximum prospective short circuit current. Miniature fuses may have an interrupting rating only 10 times their rated current. Fuses for small low-voltage wiring systems are commonly rated to interrupt 10,000 amperes. Fuses for larger power systems must have higher interrupting ratings, with some low-voltage current-limiting "high rupturing capacity" (HRC) fuses rated for 300,000 amperes. Fuses for high-voltage equipment, up to 115,000 volts, are rated by the total apparent power (megavolt-amperes, MVA) of the fault level on the circuit.

## 2.4 Voltage Rating

As well as a current rating, fuses also carry a voltage rating indicating the maximum circuit voltage in which the fuse can be used. For example, glass tube fuses rated 32 volts should never be used in line-operated (mains-operated) equipment even if the fuse physically can fit the fuseholder. Fuses with ceramic cases have higher voltage ratings. Fuses carrying a 250 V rating may be safely used in a 125 V circuit, but the reverse is not true as the fuse may not be capable of safely interrupting the arc in a circuit of a higher voltage. Medium-voltage fuses rated for a few thousand volts are never used on low voltage circuits, due to their expense and because they cannot properly clear the circuit when operating at very low voltages.

## 2.5 Markings

A sample of the many markings that can be found on a fuse.



Surface Mount Fuses on 8 mm tape. Each fuse measures 1.6 mm x 0.79 mm and has no markings.

Most fuses are marked on the body, or end caps to markings show their ratings. Surface mount technology "chip type" fuses feature little or no markings making identification very difficult.

When replacing a fuse, it is important to interpret these markings correctly as fuses that may look the same, could be designed for very different applications. Fuse markings will generally convey the following information;

- Ampere rating of the fuse
- Voltage rating of the fuse
- Time-current characteristic ie. element speed
- Approvals
- Manufacturer / Part Number / Series

## 2.6 Approvals

The majority of fuse manufacturers build products that comply with a set of guidelines and standards, based upon the application of the fuse. These requirements are devised by many different Government agencies and certification authorities. Once a fuse has been tested and proven to meet the required standard, it may then carry the approval marking of the certifying agency.

## 2.7 Packages

Fuses come in a vast array of sizes & styles to cater for the immense number of applications in which they are used. While many are manufactured in standardised package layouts to make them easily interchangeable, a large number of new styles are released into the marketplace every year. Fuse bodies may be made of ceramic, glass, plastic, fiberglass, Molded Mica Laminates, or molded compressed fibre depending on application and voltage class.

Cartridge (ferrule) fuses have a cylindrical body terminated with metal end caps. Some cartridge fuses are manufactured with end caps of different sizes to prevent accidental insertion of the wrong fuse rating in a holder. An example of such a fuse range is the 'bottle fuse', which in appearance resembles the shape of a bottle.

Fuses designed for soldering to a printed circuit board have radial or axial wire leads. Surface mount fuses have solder pads instead of leads.

Fuses used in circuits rated 200-600 volts and between about 10 and several thousand amperes, as used for industrial applications such as protection of electric motors, commonly have metal blades located on each end of the fuse. Fuses may be held by a spring loaded clip or the blades may be held by screws. Blade type fuses often require the use of a special purpose extractor tool to remove them from the fuse holder.

## 2.8 Materials

While glass fuses have the advantage of a fuse element visible for inspection purposes, they have a low breaking capacity which generally restricts them to applications of 15 A or less at 250 VAC. Ceramic fuses have the advantage of a higher breaking capacity facilitating their use in higher voltage/ampere circuits. Filling a fuse body with sand provides additional protection against arcing in an overcurrent situation.

## 2.9 High Voltage Fuses

Fuses are used on power systems up to 115,000 volts AC. High-voltage fuses are used to protect instrument transformers used for electricity metering, or for small power transformers where the expense of a circuit breaker is not warranted. For example, in distribution systems, a power fuse may be used to protect a transformer serving 1-3 houses. A circuit breaker at 115 kV may cost up to five times as much as a set of power fuses, so the resulting saving can be tens of thousands of dollars. Pole-mounted distribution transformers are nearly always protected by a fusible cutout, which can have the fuse element replaced using live-line maintenance tools.

Large power fuses use fusible elements made of silver, copper or tin to provide stable and predictable performance. High voltage *expulsion fuses* surround the fusible link with gas-evolving substances, such as boric acid. When the fuse blows, heat from the arc causes the boric acid to evolve large volumes of gases. The associated high pressure (often greater than 100 atmospheres) and cooling gases rapidly extinguish (quench) the resulting arc. The hot gases are then explosively expelled out of the end(s) of the fuse. Other special High Rupturing Capacity (HRC) fuses surround one or more parallel connected fusible links with an energy absorbing material, typically silicon dioxide sand. When the fusible link blows, the sand absorbs energy from the arc, rapidly quenching it, creating an artificial fulgurite in the process .

## 2.10 Fuses Compared With Circuit Breakers

Fuses have the advantages of often being less costly and simpler than a circuit breaker for similar ratings. The blown fuse must be replaced with a new device which is less convenient than simply resetting a breaker and therefore likely to discourage people from ignoring faults. On the other hand replacing a fuse without isolating the circuit first (most building wiring designs do not provide individual isolation switches for each fuse) can be dangerous in itself, particularly if the fault is a short circuit.

High rupturing capacity fuses can be rated to safely interrupt up to 300,000 amperes at 600 V AC. Special current-limiting fuses are applied ahead of some molded-case breakers to protect the breakers in low-voltage power circuits with high short-circuit levels.

"Current-limiting" fuses operate so quickly that they limit the total "let-through" energy that passes into the circuit, helping to protect downstream equipment from damage. These fuses clear the fault in less than one cycle of the AC power frequency. Circuit breakers cannot offer similar rapid protection.

Circuit breakers which have interrupted a severe fault should be removed from service and inspected and replaced if damaged.

Circuit Breakers must be maintained on a regular basis to ensure their mechanical operation during an interruption. This is not the case with fuses, in which no mechanical operation is required for the fuse to operate under fault conditions.

In a multi-phase power circuit, if only one fuse opens, the remaining phases will have higher than normal currents, and unbalanced voltages, with possible damage to motors. Fuses only sense overcurrent, or to a degree, over-temperature, and cannot usually be used independently with protective relaying to provide more advanced protective functions, for example, ground fault detection.

Some manufacturers of medium-voltage distribution fuses combine the overcurrent protection characteristics of the fusible element with the flexibility of relay protection by adding a pyrotechnic device to the fuse operated by external protection relays.

## 2.11 Fuse Boxes

Old electrical consumer units (also called fuse boxes) were fitted with fuse wire that could be replaced from a supply of spare wire that was wound on a piece of cardboard. Modern consumer units usually contain magnetic circuit breakers instead of fuses. Cartridge fuses were also used in consumer units and sometimes still are, as miniature circuit breakers (MCBs) are rather prone to nuisance tripping.

Renewable fuses allow user replacement of the fusewire or fuse link. The disadvantage with renewable fuses is that it is easy for people to put a higher-rated or double fuse element (link or wire) into the holder ("overfusing"), or simply fitting it with copper wire. Such tampering will not be visible on inspection of the fuse. Fuse wire was never used in North America for this reason, although renewable fuses continue to be made for distribution boards.

The box pictured is a "Wylex standard". This type was very popular in the United Kingdom up until recently when the wiring regulations started demanding Residual-Current Devices (RCDs) for sockets that could feasibly supply equipment outside the equipotential zone. The design does not allow for fitting of RCDs (there were a few wylex standard models made with an RCD instead of the main switch but that isn't generally considered acceptable nowadays either because it means you lose lighting in the event of almost any fault) or residual-current circuit breakers with overload (RCBOs) (an RCBO is the combination of an RCD and an MCB in a single unit). The one pictured is fitted with rewirable fuses but they can also be fitted with cartridge fuses and MCBs. There are two styles of fuse base that can be screwed into these units—one designed for the rewirable fusewire carriers and one designed for cartridge fuse carriers. Over the years MCBs have been made for both styles of base. With both styles of base higher rated carriers had wider pins so a carrier couldn't be changed for a higher rated one without also changing the base. Of course with rewirable carriers a user could just fit fatter fusewire or even a totally different type of wire object (hairpins, paper clips, nails etc.) to the existing carrier.

In North America, fuse boxes were formerly used in buildings wired before about 1950. These used screw-in "plug" type (not to be confused with what the British call plug fuses), in screw-thread holders similar to Edison-base incandescent lamps, with ratings of 5, 10, 15, 20, 25, and 30 amperes. To prevent installation of fuses with too high a current rating for the circuit, later fuse boxes included rejection features in the fuseholder socket. Some installations have resettable miniature thermal circuit breakers which screw into the fuse socket. One form of abuse of the fuse box was to put a penny in the socket, which defeated the overcurrent protection function and resulted in a dangerous condition. Plug fuses are no longer used for branch circuit protection in new residential or industrial construction.

## 2.12 British Plug Fuse


20 mm 200 mA glass cartridge fuse used inside equipment and 1 inch 13 A ceramic British plug fuse.

The BS 1363 13 A plug has a BS 1362 cartridge fuse inside. This allows the use of 30 A/32 A (30 A was the original size; 32 A is the closest European harmonised size) socket circuits safely. In order to keep cable sizes manageable these are usually wired in ring mains.

It also provides better protection for small appliances with thin flex as a variety of fuse ratings (1 A, 2 A, 3 A, 5 A, 7 A, 10 A 13 A with 3, 5 and 13 being the most common) are available and a suitable fuse should be fitted to allow the normal operating current while protecting the appliance and its cord as well as possible. With some loads it is normal to use a slightly higher rated fuse than the normal operating current. For example on 500 W halogen floodlights it is normal to use a 5 A fuse even though a 3 A would carry the normal operating current. This is because halogen lights draw a significant surge of current at switch on as their cold resistance is far lower than their resistance at operating temperature.

In most other wiring practices the wires in a flexible cord are considered to be protected by the branch circuit overcurrent device, usually rated at around 15 amperes, so a plug-mounted fuse is not used. Small electronic apparatus often includes a fuseholder on or in the equipment, to protect internal components only.

The rating on a BS1362 fuse specifies the maximum current the fuse can pass 'indefinitely' under standard conditions. The fuse will pass higher currents than the rated value for significant periods, depending on how high the overload is. Fuse manufacturers publish tables or graphs of fuse characteristics to allow electrical system designers to specify the correct fuse for the conditions under which it will be expected to operate. One example is the table published by Cooper-Bussmann for their BS1362 fuses. In this table it can be seen that the fuse is specified to be able to carry its rated current for a minimum of 1,000 hours; 1.6 times its rated current for a minimum of 30 minutes; and 1.9 times its rated current for a maximum of 30 minutes. Thus, this BS1362 13A fuse is only rated to break its circuit after carrying 24.7 Amps for 30 minutes.

## 2.13 Other Fuse Types

So-called "self-resetting" fuses use a thermoplastic conductive element known as a Polymeric Positive Temperature Coefficient (or PPTC) thermistor that impedes the circuit during an overcurrent condition (through increasing the device resistance). The PPTC thermistor is self-resetting in that when the overcurrent condition is removed, the device will revert back to low resistance, allowing the circuit to operate normally again. These devices are often used in aerospace/nuclear applications where replacement is difficult.

A "thermal fuse" is often found in consumer equipment such as coffee makers or hair dryers or transformers powering small consumer electronics devices. They contain a fusible, temperature-sensitive alloy which holds a spring contact mechanism normally closed. When the surrounding temperature gets too high, the alloy melts and allows the spring contact mechanism to break the circuit. The device can be used to prevent a fire in a hair dryer for example, by cutting off the power supply to the heater elements when the air flow is interrupted (e.g. the blower motor stops or the air intake becomes accidentally blocked). Thermal fuses are a 'one shot', non-resettable device which must be replaced once they have been activated

# CHAPTER THREE

# TYPES OF CIRCUITS AT INSTALLATION

## 3.1 Socket Circuits:

Commonly two kind of circuits uses at socket insallation in a bulding these are ring circuits and radial circuits

### 3.1.1 Ring Circuit:

In electricity supply, a ring final circuit or ring circuit (informally also ring main or just ring) is an electrical wiring technique developed and primarily used in the United Kingdom that provides *two* independent conductors for live, neutral and protective earth within a building for each connected load or socket.

This design enables the use of smaller-diameter wire than would be used in a radial circuit of equivalent total amperage. Ideally, the ring acts like two radial circuits proceeding in opposite directions around the ring, the dividing point between them dependent on the distribution of load in the ring. If the load is evenly split across the two directions the amperage in each direction is half of the total, allowing the use of wire with half the current-carrying capacity. In practice, the load does not always split evenly, so thicker wire is used.

### 3.1.2 Description

In a single-phase system, the ring starts at the consumer unit (also known as "fuse box" or "breaker box"), visits each socket in turn, and then returns to the consumer unit. In a three-phase system, the ring (which is almost always single-phase) is fed from a single-pole breaker in the distribution board.

Ring circuits are commonly used in British wiring with fused 13 A plugs to BS 1363. They are generally wired with 2.5 mm² cable and protected by a 30 A fuse, an older 30 A circuit breaker, or a European harmonised 32 A circuit breaker. Sometimes 4 mm² cable is used if very long cable runs (causing volt drop issues) or derating factors such as thermal insulation are involved. 1.5 mm² mineral-insulated copper-clad cable ('pyro') may also be used (as mineral insulated cable can withstand heat more effectively than normal PVC) though obviously more care must be taken with regard to voltage drop on longer runs.

Many lay people in the UK refer to any circuit as a "ring" and the term "lighting ring" is often heard from novices. It is not unheard of to see lighting circuits wired as rings of cable (though usually still with a breaker below the cable rating) in DIY installations.

### 3.1.3 History and use

The ring circuit and the associated BS 1363 plug and socket system were developed in Britiain during 1942–1947. They are commonly used in the United Kingdom and to a lesser extent in the Republic of Ireland. It is likely that they are also used in parts of the Commonwealth of Nations, where Britain had design influence in the past.

The ring main came about because Britain had to embark on a massive rebuilding programme following World War II. There was an acute shortage of copper, and it was necessary to come up with a scheme that used far less copper than would normally be the case. The scheme was specified to use 13 Amp fused socket outlets and several designs for the plugs and sockets appeared. Only the square pin (BS1363) system survives, but the round pin D&S system was still in use in many locations well into the 1980s. This latter plug had the distinctive feature that the fuse was also the live pin and unscrewed from the plug body.

The ring circuit was devised during a time of copper shortage to allow two 3 kW heaters to be used in any two locations and to allow some power to small appliances, and to keep total copper use low. It has stayed the most common circuit configuration in the UK although the 20 A radial (essentially breaking each ring in half and putting the halves on a separate breaker) is becoming more common. Splitting a ring into two 20 A radials can be a useful technique where one leg of the ring is damaged and cannot easily be replaced.

Another advantage of ring circuits in their early days was an economy of cable and labour, due to the fact that one could simply connect a cable between two existing 15A radially wired sockets to make one 30A ring, then adding as many sockets as were desired. This was an important consideration in the austerity of the 1940s. This would leave the ring supplied by 2x 15A fuses, which worked well enough in practice, even if unconventional.

Many pre-war (round pin) installations used double pole fusing. When 2x 15A radials were converted to a ring on these systems, the ring would then be supplied by no less than 4 fuses! It is rare to find such circuits still in service today.

### 3.1.4 Installation Rules

Rules for ring circuits say that the cable rating must be no less than two thirds of the rating of the protective device. This means that the risk of sustained overloading of the cable can be considered minimal. In practice, however, it is extremely uncommon to encounter a ring with a protective device other than a 30A fuse, 30A breaker or 32A breaker, and a cable size other than those mentioned above.

The IEE Wiring Regulations (BS 7671) permit an unlimited number of socket outlets to be installed on a ring circuit, provided that the floor area served does not exceed 100 $m^2$. In practice most small and medium houses have one ring circuit per storey, with larger premises having more.

An installation designer may determine by experience and calculation whether additional circuits are required for areas of high demand - for example it is common practice to put kitchens on their own ring circuit or sometimes a ring circuit shared with a utility room to avoid putting a heavy load at one point on the main downstairs ring circuit. A heavy concentration of load close together on a ring circuit can cause minor overloading of one of the cables if near the end of the ring, so kitchens should not be wired at one end of a ring circuit.

Unfused spurs from a ring wired in the same cable as the ring are allowed to run one single or double socket (the use of two singles was previously allowed but was banned because of people replacing them with doubles) or one fused connection unit (FCU). Spurs may either start from a socket or be joined to the ring cable with a junction box or other approved method of joining cables. Triple and larger sockets are generally fused and therefore can also be placed on a spur.

It is not permitted to have more spurs than sockets on the ring, and it is considered bad practice by most electricians to have spurs in a new installation (some think they are bad practice in all cases).

Where loads other than BS 1363 sockets are connected to a ring circuit or it is desired to place more than one socket for low power equipment on a spur, a BS 1363 fused connection unit (FCU) is used. In the case of fixed appliances this will be a switched fused connection unit (SFCU) to provide a point of isolation for the appliance, but in other cases such as feeding multiple lighting points (putting lighting on a ring through is generally considered bad practice in new installation but is often done when adding lights to an existing property) or multiple sockets, an unswitched one is often preferable.

Fixed appliances with a power rating over 3 kW (for example, showers and some electric cookers) or with a non-trivial power demand for long periods (for example, immersion heaters) are no longer recommended to be connected to a ring circuit, but instead are connected to their own dedicated circuit. There are however plenty of older installations with such loads on a ring circuit.

## 1.5Criticism

The final ring-circuit concept has been criticized in a number of ways, and some of ese disadvantages could explain the lack of widespread adoption outside the United ingdom.

The only way to see the pros and cons of ring circuits is to compare them to the other otion, radials.

## 1.6 Fault Conditions Are Not Apparent When In Use

Ring circuits continue to operate without the user being aware of any problem if there e fault conditions or installation errors that make the circuit unsafe

Part of the ring missing or loose connections result in 2.5 mm² cables running above ted current at times, resulting in reduced cable life.

Radials with a loose connection will overheat severely and be an immediate fire risk

Radials with a broken connection will not function (if L or N broken), or function with o safety earth connection (if E broken).

Accidental cross connection between two 32 A rings means that the fault current rotection reaches 64 A and the required fault disconnection times are violated grossly

Testing at installation addresses this.

Ring spur installations encourage using three connectors in one terminal, which can ause one to become loose and overheat

The same situation occurs with both radial and ring circuits when branching off is sed.

- Rings encourage the installation of too many spurs on a ring, leading to a risk of overheating, especially if spur cables are too long

### 3.1.7 Complexity Of Safety Tests

Testing ring circuits takes 5–6 times longer than testing radial circuits. The installation tests required for the safe operation of a ring circuit are substantially more time consuming than those for a radial circuit, and DIY installers or electricians qualified in other countries may not be familiar with them.

### 3.1.8 Balancing Requirement

Regulation 433-02-04 of BS 7671 requires that the installed load is distributed around the ring such that no part of the cable exceeds its capacity. This requirement is difficult to fulfill and may be largely ignored in practice, as loads are often co-located (washing machine, tumble dryer, dish washer all next to kitchen sink) and not necessarily near the centre of the ring.

### 3.1.9 Electromagnetic Interference

Ring circuits can generate strong unwanted magnetic fields. In a normal (non-ring, radial) circuit, the current flowing in the circuit must return through (almost exactly) the same path through which it came, especially if the live and neutral conductors are kept in close proximity of each other and form a twisted pair. This prevents the circuit forming a large magnetic coil (loop antenna), which would otherwise induce a magnetic field at the AC frequency (50 or 60 Hz). In a ring circuit, on the other hand, it is possible that the live and neutral currents are not equal on each side of the ring. Mains-frequency currents follow the path of least resistance, and it is possible, especially with aging oxidized contacts, that from a socket, the lowest-resistance *live* connection is along the left-hand side of the ring, and the lowest-resistance *neutral* connection is along the right-hand side. As a result, current is flowing *around* the ring and will therefore induce a magnetic field. In the extreme case of a defect ring circuit, the live connection could become completely interrupted on one side of the ring and the neutral connection on the other, and then the full current would supply the magnetic field. This can lead to substantial electromagnetic interference, such as such as mains hum in audio devices, accidental triggering of alarm and protection devices (burglar alarms, RCDs, etc.), malfunctions of consumer electronics and medical devices, ground loops, etc.

On the other hand high resistance connections on radial circuits result in overheating and fire risk, a much more serious problem.

### 3.1.10 Overcurrent Protection

Ring circuits provide low protection against overcurrents. The purpose of ring circuits is to supply a large number of sockets, therefore they are protected only with high-rated overcurrent circuit breakers (typically 32 A). In comparison, the radial circuits used in other countries typically supply only a small number of sockets and are therefore protected with lower-rated circuit breakers (typically 10–16 A). As a result, countries using ring circuits find it necessary to add additional lower-rated fuses into the plugs of each appliance. This creates an improvement in safety in that an appliance with blown plug fuse will not be live when plugged in again, whereas with fuseless plugs a faulty appliance remains dangerous to plug in, and another person will often do so at a later date.

This incompatibility in the overcurrent protection of appliance leads between countries using ring and radial circuits has been a major stumbling block on the road to worldwide standardization of domestic AC power plugs and sockets. Although plug-fuses can, in principle, be better matched to the maximum current required by an appliance, in practice, some plugs in the UK are merely fitted with a fuse of the maximum permitted rating of 13 A, resulting in safety improvement with some appliances but not all. This is not a problem since all appliances are required to be safe with a 13A fuse, but it does mean the potential safety advantage is only partially realised. The introduction of regulations requiring new appliances to be sold with correctly fused pre-fitted plugs improves this situation further.

### 3.1.11 Radial Circuit

These circuits have a twin and earth cable running from the consumer unit to each of the socket outlets or fused connection units in turn, one after another, but it stops at the last one. There is no return cable back to the consumer unit from the last socket or unit. There is no limit to the number of socket outlets / fused connection units supplied, and spurs may be added. The cable used and the fuse required may differ from a ring main, depending on the application. Large appliances often have to be on their own circuit. Be sure you know the regulations before attempting any work.

These include the following:For a floor area up to 20 m sq, 2.5 mm sq cable is used and the circuit is protected by a 20 amp fuse. The maximum length of cable is 35 m when a cartridge fuse is fitted and 33 m with an MCB.

For a floor area up to 50 m sq, 4 mm sq cable is used and the circuit is protected by a 30 amp cartridge fuse or 32 amp MCB. The maximum length of cable is 38 m when a cartridge is fitted and 15 m with an MCB. It should be noted that the rewireable fuse is not allowed in this instance.

Large appliances like cookers must be supplied by their own separate radial circuit.

## 2.1 Switches

switch is a mechanical device used to connect and disconnect a circuit at will. vitches cover a wide range of types, from subminiature up to industrial plant switching egawatts of power on high voltage distribution lines.

In applications where multiple switching options are required (e.g., a telephone rvice), mechanical switches have long been replaced by electronic switching devices which n be automated and intelligently controlled.

The prototypical model is perhaps a mechanical device (for example a railroad switch) hich can be disconnected from one course and connected to another.

The switch is referred to as a "gate" when abstracted to mathematical form. In the ilosophy of logic, operational arguments are represented as logic gates. The use of ectronic *gates* to function as a system of logical gates is the fundamental basis for the i.e. a omputer is a system of electronic switches which function as logical gates.

## 2.2 A Simple Electrical Switch

simple semiconductor switch is a transistor.

**2.3Contacts**

In the simplest case, a switch has two pieces of metal called *contacts* that touch to ake a circuit, and separate to break the circuit. The contact material is chosen for its sistance to corrosion, because most metals form insulating oxides that would prevent the vitch from working. Contact materials are also chosen on the basis of electrical conductivity, ırdness (resistance to abrasive wear), mechanical strength, low cost and low toxicity

Sometimes the contacts are plated with noble metals. They may be designed to wipe ;ainst each other to clean off any contamination. Nonmetallic conductors, such as ›nductive plastic, are sometimes used.

**2.4 Actuator**

The moving part that applies the operating force to the contacts is called the actuator, d may be a toggle or *dolly*, a rocker, a push-button or any type of mechanical linkage

**2.5 Biased Switches**

A biased switch is one containing a spring that returns the actuator to a certain sition. The "on-off" notation can be modified by placing parentheses around all positions ıer than the resting position. For example, an (on)-off-(on) switch can be switched on by oving the actuator in either direction away from the centre, but returns to the central off sition when the actuator is released.

The momentary push-button switch is a type of biased switch. The most common type a push-to-make switch, which makes contact when the button is pressed and breaks when button is released. A push-to-break switch, on the other hand, breaks contact when the ton is pressed and makes contact when it is released. An example of a push-to-break itch is a button used to release a door held open by an electromagnet. Changeover push ton switches do exist but are even less common.

### .6 Special Types

Switches can be designed to respond to any type of mechanical stimulus: for example, ration (the trembler switch), tilt, air pressure, fluid level (the float switch), the turning of a y (key switch), linear or rotary movement (the limit switch or microswitch), or presence of nagnetic field

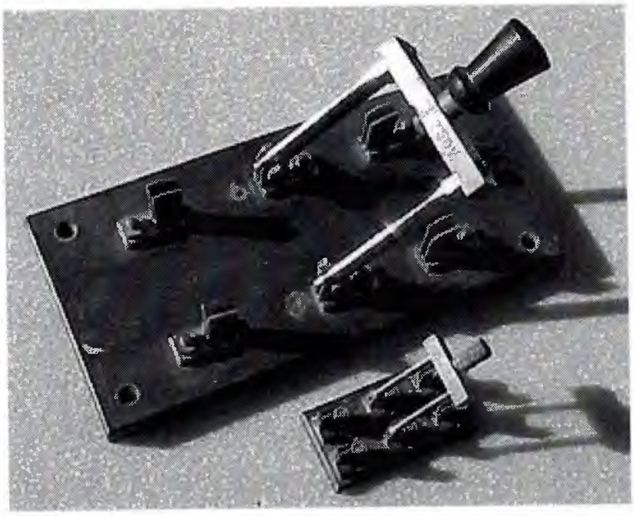
### 2.7 Mercury Tilt Switch

The mercury switch consists of a drop of mercury inside a glass bulb with 2 contacts. e two contacts pass through the glass, and are connected by the mercury when the bulb is ed to make the mercury roll on to them.

This type of switch performs much better than the ball tilt switch, as the liquid metal nnection is unaffected by dirt, debris and oxidation, it wets the contacts ensuring a very low istance bounce free connection, and movement and vibration do not produce a poor ntact.

### .8 Knife Switch

Knife switches are a more or less obsolete type of power switch used in the 1800s. The e (hot) parts of the switch are uncovered and uninsulated, and they are unsuitable for use at ock-risk voltages. Knife switches have a relatively large contact spacing when open, so in 1800s were often used to control power machinery running at high voltage, a use that can ly be considered dangerous.



Knife switches are seen in horror films set in the 1800s, especially in underground oratories, and have something of an association with Frankenstein et al.

Today knife switches are used in demonstrations, where the large size and simple echanism make for easy and immediate understanding of operation. They are also metimes encountered in heavy-duty industrial applications

### 2.9 Intermediate Switch

A DPDT switch has six connections, but since polarity reversal is a very common sage of DPDT switches, some variations of the DPDT switch are internally wired ecifically for polarity reversal. These crossover switches only have four terminals rather an six. Two of the terminals are inputs and two are outputs. When connected to a battery or her DC source, the 4-way switch selects from either normal or reversed polarity. termediate switches are also an important part of multiway switching systems with more an two switches (see next section).

### 2.10 Multiway Switching

Multiway switching is a method of connecting switches in groups so that any switch an be used to connect or disconnect the load. This is most commonly done with lighting.

**Two Locations**

1.Firstmethod

2.Secondmethod

3. Labelling of switch terminals

Switching a load on or off from two locations (for instance, turning a light on or off from either end of a flight of stairs) requires two SPDT switches. There are two basic methods of wiring to achieve this, and another not recommended.

In the first method, mains is fed into the common terminal of one of the switches; the switches are then connected through the L1 and L2 terminals (swapping the L1 and L2 terminals will just make the switches work the other way round), and finally a feed to the light is taken from the common of the second switch. A connects to B or C, D connects to B or C; the light is on if A connects to D, i.e. if A and D both connect to B or both connect to C.

The second method is to join the three terminals of one switch to the corresponding terminals on the other switch and take the incoming supply and the wire out to the light to the L1 and L2 terminals. Through one switch A connects to B or C, through the other also to B or C; the light is on if B connects to C, i.e. if A connects to B with one switch and to C with the other.

Wiring needed in addition to the mains network (not including protective earths):

**First Method:**

- double wire between both switches
- single wire from one switch to the mains
- single wire from the other switch to the load

- single wire from the load to the mains

**Second Method:**

- triple wire between both switches
- single wire from any position between the two switches, to the mains
- single wire from any position between the two switches, to the load
- single wire from the load to the mains

If the mains and the load are connected to the system of switches at one of them, then in both methods we need three wires between the two switches. In the first method one of the three wires just has to pass through the switch, which tends to be less convenient than being connected. When multiple wires come to a terminal they can often all be put directly in the terminal. When wires need to be joined without going to a terminal a crimped joint, piece of terminal block, wirenut or similar device must be used and the bulk of this may require use of Using the first method, there are four possible combinations of switch positions: two with the light on and two with the light off.

### 3.2.11 An Unrecommended Method

The unrecommended way using the hot and neutral directly

If there is a hot (a unique phase) and a neutral wire in both switches and just one wire between them where the light is connected (as in the picture), you can then solve the two way switch problem easily: just plug the hot in the top from switch, the neutral in the bottom from switch and the wire that goes to the light in the middle from the switch. This in both switches. Now you have a fully functional two way switch.

This works like the first method above: there are four possibilities and just in two of hem there is a hot and a neutral connected in the poles of the light. In the other ones, both poles are neutral or hot and then no current flows because the potential difference is zero.

The advantage of this method is that it uses just one wire to the light, having a hot and neutral in both switches.

The reason why this is not recommended is that the light socket pins may still be hot even with the light off, which poses a risk when changing a bulb. Another problem with this method is that in both switches there will be hot and neutral wires entering a single switch, which can lead to a short circuit in the event of switch failure, unlike the other methods.

This method is in defiance of the NEC and the CEC. In nearly any and all applications, neutral conductors should never be switched. Not only is this a shock hazard due to mistakenly believing that a hot conductor is switched off; it is also a fire hazard and can destroy sensitive equipment due to excessive and unbalanced current flowing on hot conductors that would outherwise flow back to ground on the neutral conductor.

### 3.2.12 More Than Two Locations

Three-wayswitching.

1.Firstmethod
2.Secondmethod
3. Labelling of switch terminals

For more than two locations, the two cores connecting the L1 and L2 of the switches must be passed through an intermediate switch (as explained above) wired to swap them over. Any number of intermediate switches can be inserted, allowing for any number of locations.

Wiring needed in addition to the mains network (not including protective earths):

**First Method:**

- double wire along the sequence of switches
- single wire from the first switch to mains
- single wire from the last switch to the load
- single wire (neutral) from load to mains

**Second Method:**

- double wire along the sequence of switches
- single wire from first switch to last switch
- single wire from anywhere between two of the switches to the mains
- single wire from anywhere between the same two switches to the load
- single wire (neutral) from load to mains

Using the first method, there are eight possible combinations of switch positions: four with the light on and four with the light off

### 3.2.13 Distance Equipments From Ground

| | |
|---|---|
| The switches from ground | 150 cm |
| The sockets from ground | 40 cm |
| The wall lamp from ground | 190 cm |
| The conduit box from ground | 220 cm |
| The fuse box from the ground | 200 cm |

.CHAPTER FOUR

# INFORMATION ABOUT CABLES

## .1 What Is Cable?

Cable is one or more wires or optical fibers bound together, typically in a common rotective jacket or sheath. The individual wires or fibers inside the jacket may be covered or nsulated. Combination cables may contain *both* electrical wires and optical fibers. Electrical vire is usually copper because of its excellent conductivity, but aluminum is sometimes used ecause it costs less.

## 4.2 Construction

Electrical cables may be made flexible by stranding the wires. In this process, smaller individual wires are twisted or braided together to produce larger wires that are more flexible than solid wires of similar size. Bunching small wires before concentric stranding adds the most flexibility. A thin coat of a specific material (usually tin-which improves the solderability of the bunch-, but it could be silver, gold and another materials and of course the wire can be unplated - with no coating material) on the individual wires provides lubrication for longest life. Tight lays during stranding makes the cable extensible (CBA - as in telephone handset cords).

Bundling the conductors and eliminating multi-layers ensures a uniform bend radius across each conductor. Pulling and compressing forces balance one another around the high-tensile center cord that provides the necessary inner stability. As a result the cable core remains stable even under maximum bending stress.

Cables can be securely fastened and organized, such as using cable trees with the aid of cable ties or cable lacing. Continuous-flex or flexible cables used in moving applications within cable carriers can be secured using strain relief devices or cable ties.

## 4.3 Cables As A Fire Hazard

In construction, sometimes the cable jacketing is seen as a potential source of fuel for a fire. To limit the spread of fire along cable jacketing, one may use cable coating materials or one may use cables with jacketing that is inherently fire retardant. Teck cable or metal clad cables, may have exterior organic jacketing, which is often stripped off by electricians in order to reduce the fuel source for accidental fires. In Europe in particular, it is often customary to place inorganic wraps and boxes around cables in order to safeguard the adjacent areas from the potential fire threat associated with unprotected cable jacketing.

## 4.4 Interference Protection

In applications powering sensitive electronics, keeping unwanted EMI/RFI from entering circuits is important. This can be accomplished passively with shielding along the length of the cable or by running the cable in an enclosure separate from any other wires which may induct noise. It can also be actively achieved by use of a choke designed to restrict the cables' ability to conduct certain frequencies.

## 4.5 Power Cable

A power cable is an assembly of two or more electrical conductors, usually held together with an overall sheath. The assembly is used for transmission of electrical power. Power cables may be installed as permanent wiring within buildings, buried in the ground, run overhead, or exposed. Flexible power cables are used for portable and mobile tools and machinery

## 4.6 Construction

Modern power cables come in a variety of sizes, materials, and types, each particularly adapted to its usesLarge single insulated conductors are also sometimes called power cables in the industry.

Cables consist of three major components, namely conductors, insulations, protection. The constructional detail of individual cables will vary according to their application. The construction and material are determined by three main factors:

- Working voltage, which determines the thickness and composition of the insulation;
- Current carrying capacity, which determines the cross-section size of the conductors;
- Environmental conditions such as temperature, chemical or sunlight exposure, and mechanical impact, which determines the form and composition of the cable jacket enclosing conductors.

Since power cables must be flexible, the copper or aluminum conductors are made of stranded wire, although very small power cables may use solid conductors. The cable may include uninsulated conductors used for the circuit neutral or for ground (earth) connection.

The overall assembly may be round or flat. Filler strands may be added to the assembly to maintain its shape. Special purpose power cables for overhead or vertical use may have additional elements such as steel or Kevlar structural supports.

For circuits operating at 2,400 volts between conductors or more, a conductive shield may surround each conductor. This equalizes electrical stress on the cable insulation. This technique was patented by Martin Hochstadter in 1916 and so the shield is sometimes called a Hochstadter shield. The individual conductor shields of a cable are connected to earth ground at one or both ends of each length of cable.

Some power cables for outdoor overhead use may have no overall sheath. Other cables may have a plastic or metal sheath enclosing all the conductors. The materials for the sheath will be selected for resistance to water, oil, sunlight, underground conditions, chemical vapors, impact, or high temperatures. Cables intended for underground use or direct burial in earth will have heavy plastic or lead sheaths, or may require special direct-buried construction. Where cables must run where exposed to impact damage, they are protected with flexible steel tape or wire armor, which may also be covered by a water resistant jacket.

Cables for high-voltage (more than 65,000 volts) power distribution may be insulated with oil and paper, and are run in a rigid steel pipe, semi-rigid aluminium or lead jacket or sheath. The oil is kept under pressure to prevent formation of voids that would allow partial discharges within the cable insulation. Newer high-voltage cables use cross linked polyethylene (XLPE) for insulation.

A hybrid cable will include conductors for control signals or may also include optical fibers for data.

## 4.7 Named Cable Types

Common types of general-purpose cables used by electricians are defined by national or international regulations or codes. Commonly-used types of power cables are often known by a "shorthand" name. For example, NEC type *NM-B* (*Non-Metallic, variant B*), often referred to as Romex™ (named by the Rome Wire Company, now a trademark of Southwire Company), is a cable with a nonmetallic jacket. *UF* (*underground feeder*) is also nonmetallic but uses a moisture- and sunlight-resistant construction suitable for direct burial in the earth or where exposed to sunlight, or in wet, dry, or corrosive locations. Type AC is a fabricated assembly of insulated conductors in a flexible metallic armor, made by twisting an interlocking metal strip around the conductors. *BX*, an early genericized trademark of the General Electric company was used before and during World War II, designating a particular design of armored cable.

In Canada, type TECK cable, with a flexible aluminum or steel armor and overall flame-retardant PVC jacket, is used in industry for wet or dry locations, run in trays or attached to building structure, above grade or buried in earth. A similar type of cable is designated type MC in the United States.

Electrical power cables are often installed in raceways including electrical conduit, and cable trays, which may contain one or more conductors.

Mineral-insulated copper-clad cable (type *MI*) is a fire-resistant cable using magnesium oxide as an insulator. It is used in demanding applications such as fire alarms and oil refineries.

## 4.8 Flexible Cables

All cables are flexible, which allows them to be shipped to installation sites on reels or drums. Where applications require a cable to be moved repeatedly, more flexible cables are used. Small cables are called "cords" (North American usage) or "flex" (United Kingdom) Flexible cords contain finer stranded conductors, rather than solid, and have insulation and sheaths that are engineered to withstand the forces of repeated flexing. Heavy duty flexible power cords such as feeding a mine face cutting machine are carefully engineered -- since their life is measurable in weeks. Very flexible power cables are used in automated machinery, robotics, and machine tools. See "power cord" and "extension cable" for further description of flexible power cables. Other types of flexible cable include twisted pair, extensible, coaxial, shielded, and communication cable.

## 4.9 Air Cable

An air cable is an insulated cable usually containing all conductors required for an electrical transmission system or a telecommunication line, which is spun between poles or pylones. Further air cables of fiberoptic basic are also available. As air cables are completely insulated there is no danger of electrical shocks when touching them and there is no requirement for mounting them with insulators on pylons and poles. A further advantage of air cables is, that they require a less right of way than overhead lines for same purpose and that there is less danger of interference as they can be designed as shielded cables ( for telecommunication purposes) or that in case of pylon failure or hit by a fallen tree the line is still functional, if insulation is not destroyed by this incident. Also reparation may be possible in many cases without interruption.

As air cables are installed on pylons or poles, they may be cheaper to install than underground cables as no work for digging is required, which can be very expensive at rocky areas.

## 4.10 Useage Of Air Cables

Air cables are mostly used for telecommunication systems or for power transmissions with voltages below 1000 volts, although air cable systems for voltages around 10000 volts were also realized, especially for the supply of farms, waterworks, transmitters and other facilities outside urban areas. A further common use is the replacement of overhead telecommunication lines for example along railway lines by air cables as they can be installed on existing poles and make the facility more reliable. Telecommunication systems running along power lines or aerial tramways are often built as air cables as they can be easily installed on the pylons respectively aerial tramway support towers. However these cables must be designed for higher forces as span widths are longer. At powerlines the air cable can serve also as ground conductor on the top of the pylon. It can be also installed in form of a separate rope on the conductor. A special method was used at former EVS ( now EnBW)in Germany until Mid of 1980ies, where the air cable was installed like a garland on the ground conductor or an auxiliary rope.

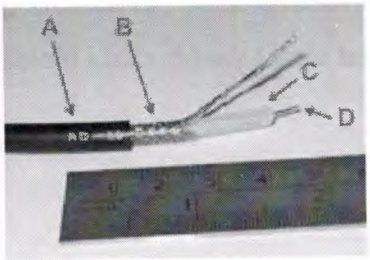
Air cable spun like a garland on a 110kV-powerline of EnBW AG near Leonberg in Germany

For reasons of electromagnetic interference air cables running along powerlines are most often of fibreoptic types. As these are dielectric, it is even possible to install them directly in the conductors, which is also sometimes realized. Air cables are also used sometimes for power transmission from the transmitter building to the antenna at radio stations.

## 4.11 Coaxial Cable

Coaxial cable is an electrical cable consisting of an inner conductor surrounded by an insulating spacer, surrounded by an outer cylindrical conductor. The term coaxial comes from the inner conductor and the outer shield sharing the same geometric axis. Coaxial cables are often used as a transmission line for radio frequency signals. In a hypothetical ideal coaxial cable the electromagnetic field carrying the signal exists only in the space between the inner and outer conductors. Practical cables achieve this objective to a high degree. A coaxial cable provides protection of signals from external electromagnetic interference, and effectively guides signals with low emission along the length of the cable

## 4.12 Description



RG-59flexible cable.

A: outer plastic sheath

B: copper screen

C: inner dielectric insulator

D: copper core

Coaxial cable design choices affect physical size, frequency performance, attenuation, power handling capabilities, flexibility, and cost. The inner conductor might be solid or stranded; stranded is more flexible. To get better high-frequency performance, the inner conductor may be silver plated. Sometimes copper-plated iron wire is used as an inner conductor.

The insulator surrounding the inner conductor may be solid plastic, a foam plastic, or may be air with spacers supporting the inner wire. The properties of dielectric control some electrical properties of the cable. A common choice is a solid polyethylene (PE) insulator. Lower-loss cables will use a polyethylene foam insulator. Solid Teflon is also used as an insulator. Some coaxial lines use air (or some other gas) and have spacers to keep the inner conductor from touching the shield.

There is also a lot of variety in the shield. Conventional coaxial cable had braided copper wire forming the shield. That allowed the cable to be flexible, but it also means there are gaps in the shield layer. It also means the inner dimension of the shield varies slightly because the braid cannot be flat. Sometimes the braid is silver plated. For better shield performance, some cables have a double-layer shield. The shield might be just two braids, but it is more common now to have a thin foil shield covered by a wire braid. Some cables may invest in more than two shield layers. Other shield designs sacrifice flexibility for better performance; some shields are a solid metal tube. Those cables cannot take sharp bends: the shield kinks. Many Cable television (CATV) distribution systems used such cables.

The insulating jacket can be made from many materials. A common choice is PVC, but applications may require fire-resistant materials. Outdoor applications may require the jacket to resist ultraviolet light and oxidation. For internal chassis connections the insulating jacket may be omitted.

Connections to the ends of coaxial cables are usually made with RF connectors.

## .13 Table Of Capacity Of Cables Carry Current At Underground

| Ares of calbes (mm2) | *Number of lines (number)* | *Current carry Capacity (A)* |
|---|---|---|
| 2*2.5 | 1 | 41 |
| 2*4 | 1 | 53 |
| 2*6 | 1 | 66 |
| 2*10 | 1-7 | 88 |
| 3*2.5 | 1 | 36 |
| 3*4 | 1 | 46 |
| 3*6 | 1 | 58 |
| 3*10 | 1-7 | 77 |
| 4*2.5 | 1 | 36 |
| 4*4 | 1 | 46 |
| 4*6 | 1 | 58 |
| 4*10 | 1-7 | 77 |
| 4*16 | 1-7 | 100 |
| 3*25+16 | 7 | 130 |
| 3*35+25 | 7-19 | 155 |
| 3*50+25 | 19 | 185 |
| 3*70+35 | 19 | 230 |
| 3*95+50 | 19 | 275 |
| 3*120+7 | 37 | 315 |
| 3*150+7 | 37 | 355 |
| 3*185+9 | 37 | 400 |
| | | |

# CHAPTER FIVE

# EARTHING

## 5.1 Definition Of Earthing

The purpose of earthing is to ensure that no person operating an electrical installation can receive an electric shock which could cause injury or a fatality. In simple terms, ' earthing ' involves the connection of all metalwork associated with the electrical installation with protective conductors ( CPCs ) which are terminated at a common point, the main earth terminal. This terminal is further connected to a proven earth connection which can be the supply authority's wire-armoured supply cable, an over head line conductor or an earth electrode driven directly into the soil. The availability of one or other of these connections depends on the type of electrical system used to supply electricity.

Apart from the ' exposed conductive parts ' found in an installation, there is other metalwork which has nothing to do with the electrical installation but which could become live in the event of a fault to earth. This metalwork is known as 'extraneous conductive parts' and includes hot and cold water pipes, radiators, structural steelwork, metal-topped sink units and metallic ducting used for ventilation. These parts are connected by means of,

(a) Main bonding conductors and (b) supplementary bonding conductors. The former are used to bond together metallic services at their point of entry into a building. The latter are used to bond together metallic pipes and the like within the installation. These bonding conductors are also taken to the installation's main earth terminal. Thus all metalwork in a building is at earth potential.

Once all CPCs and bounding conductors are taken to the main earth terminal, the building is known as an 'equipotential zone' and acts as a kind of safety cage in which persons can be reasonably assured of being safe from serious electric shock. Any electrical equipment taken outside the equipotential zone, such as an electric lawnmower, must be fed from a socket-outlet which incorporates a residual current device (RCD). The word 'equipotential' simply means that every single piece of metal in the building is at earth potential.

The earthing of all metalwork does not complete the protection against electric shock offered to the consumer. Overcurrent devices are required to operate within either 0.5 second or 4 second if a fault to earth occurs. And the use of RCDs also offers further protection in situations when an earth fault may not produce sufficient current to operate overcurrent protective devices.

Even before the days of electricity supply on a commercial scale, the soil has been used as a conductor for electrical currents. In early telegraphy systems the earth was used as a return conductor. The early scientists discovered that charges of electricity could be dissipated by connecting a charged body to general mass of earth by using suitable electrodes, of which the earliest form was a metal plate (the earth plate). But the earth has many failings as a conductor. This is because the resistance of soils varies with their composition. When completely dry, most soils and rocks are non-conductors of electricity. The exceptions to this are, of course, where metallic minerals are present to form conducting paths. Sands, loams and rocks can therefore be regarded as non-conductors; but when water or moisture is present; their resistivity drops to such a low value that they become conductors though very poor ones. This means that the resistivity drops to such a low poor ones. This means that the resistivity of a soil is determined by the quantity of water present in it and on the resistivity of the water itself. It also means that conduction through the soil is in effect conduction through the water, and so is of an electrolytic nature.

For all that the earth is an inefficient conductor; it is widely used in electrical work. There are three main functions of earthing:

- To maintain the potential of any part of a system at a definite value respect to earth.

- To allow current to flow to earth in the event of fault, so that the protective gear will operate to isolate the faulty circuit.

- To make sure that, in the event of a fault, apparatus normally 'dead' cannot reach a dangerous potential with respect to earth.

IEE Regulation 130 – 04 states that where metalwork, other than current-carrying conductors, is liable to become charged with electricity in such a manner as to create a danger if the insulation of a conductor should become defective, or if a defect should occur in any apparatus (I) the metalwork shall be earthed in such a manner as will ensure immediate electrical discharge without danger.

The basic reason for earthing is to prevent or to minimize the risk of shock to human beings. If an earth fault occurs in an installation it means that a live conductor has come into contact with metal-work to cause the metalwork to become live that is, to reach the same potential or voltage as the live conductor. Any person touching the metalwork, and who is standing on a non insulating floor, will receive an electric shock as the result of the current flowing through the body to earth. If however, the metalwork is connected to the general mass of earth through a low resistance path, the circuit now becomes a parallel branch circuit with:

A. the human body as one branch with a resistance of, say, 10 000 ohms; and

B. the CPC fault path as the other branch with a resistance of 1 ohm or less.

The result of properly earthed metalwork is that by far the greater proportion of fault-rrent will flow through the low-resistance path, so limiting the amount of current is really avy ( as in a direct short circuit ) then a fuse will blow or a protective device will operate. owever an earth fault current may flow with a value not sufficient to blow a fuse yet more an enough to cause over heating at say, a loose connection to start a fire.

## 2 The Main Basic Requirements Are:

- The complete insulation of all parts of an electrical system. This involves the use of paratus of 'all-insulated' construction, which means that the insulation which encloses the paratus is durable and substantially continuous.
- The use of appliances with double insulation conforming to the British Standard ecifications.
- The earthing of exposed metal parts
- The isolation of metalwork in such a manner that it is not liable to come into contact th any live parts or with earthed metalwork.

The basic requirements for good earthing are that the earthing arrangements of the nsumer's installation are such that the occurrence of a fault of negligible impedance from a ase or non earthed conductor to adjacent exposed metal, a current corresponding to three nes the fuse rating or 1.5 times the setting of an overcurrent circuit breaker can flow, so that e faulty circuit is made dead. The earthing arrangement should be such that the maximum stained voltage developed under fault conditions between exposed metal required to be rthed and the consumer's earth terminal should not exceed 50 V.

The IEE Regulations detail the metalwork found in premises, called 'extraneous nductive parts ', which are required to be connected to the installations main earthing rminal. Bathroom and showers are also covered.

The CPC is the conductor which bonds all metalwork required to be earthed. If it is a parate conductor (insulated and green coloured green) it must be at least 1/1.13 sa = 1.00 mm$^2$) and need not be greater than 70 mm$^2$. Note that conduit and trunking may used as the sole CPC except in agricultural installations.

Where metal conduit is used as a CPC, a high standard of workmanship in installation essential. Joints must be really sound. Slackness in the joints may result in deterioration in, d even complete loss of, continuity. For outdoor installations and where otherwise bjected to atmospheric corrosion, screwed conduit installations, the liberal use of locknuts recommended. Joints in all conduit systems should be painted overall after assembly. In ixed installations (e.g. aluminium-alloy conduit with steel fittings, or steel conduit with uminium-alloy or zinc-base-alloy fittings) the following are sound recommendations to isure the electrical continuity of joints.

All threads in aluminium or zinc alloys should be cut using a suitable lubricant. A rotective material (e.g. petroleum jelly) should be applied to the threads in all materials when e joint are made up. All joints should be made tight. The use of locknuts is advised. In ddition, it is recommended to apply bituminized paint to the outside of all joints after ssembly. In damp conditions, electrolytic corrosion is liable to occur at contacts between issimilar metals. To avoid this, all earthing clamps and fittings in contact with aluminium-ase-alloy tubing should be of an alloy or finish which is known from experience to be uitable. Copper, or alloys with a high copper content, are particularly liable to cause orrosion when in contact with aluminium-base alloys. For this reason, brass fixing screws or addles should not be used with conduit of fittings of aluminium base alloys. Periodical tests hould be made to ensure that electrical continuity is satisfactorily maintained. Flexible conduits should not be used as a CPC. Where flexible tubing force part of an earthed metal conduit system, a separate copper-alloy CPC should be installed with the tubing and connected to it at each end.

The earth-conductor lead should be of a minimum size: 6 mm$^2$, expect 2.5 mm$^2$ is accepted for connection to an earth-leakage circuit-breaker. It must also be protected against mechanical damage and corrosion, and not less than half the largest size of the conductor to be protected, but need normally exceed 70 mm$^2$.

*There are a number of methods used to achieve the earthing of an installation:*

1. Connection to the metal sheath and armouring of a supply authority's underground supply cable

2. Connection to the continuous earth wire (CEW) provided by a supply authority where the distribution of energy is by overhead lines.

3. Connection to an earth electrode sunk in the ground for the purpose.

4. Installation of a protective-multiple earthing system.

5. Installation of automatic fault protection.

One disadvantage in using a mains water-pipe is that sections of the pipe may be replaced by sections of non-conducting material (PVC or asbestos), which makes the pipe an inconsistent earth electrode. The provision of a cable sheath as an earthing connection is very common nowadays. Usually, however, it is accepted that if, for any reason, the earthing is subsequently proved ineffective, the supply authority except in those areas which have extremely high values of soil resistivity (e.g. peat and rock). The CEW is sometimes called an aerial earth. Connection to an earth electrode sunk in the ground is the most common means of earthing. The earth electrode can be any one of the following forms :

*a.Pipe:*

Generally a 200 mm diameter cast-iron pipe, 2 m long and buried in a coke –filled pot. This type requires a certain amount of excavation; iron is, of course, prone to corrosion, particularly if the coke has high sulphur content.

*b.Plate:*

Plate electrodes are normally of cast-iron, buried vertically with
The centre about 1 m below the surface. Copper plates may also be used. Plate electrodes

Provide a large surface area and used mainly where the ground is shallow (where the resistivity is low near the surface but increases rapidly with depth). Again, excavation is required. Care is needed to protect the earth-electrode connection (to the earthing lead) from corrosion.

*c.Strip:*

Copper strip is most useful in shallow soil overlying rock. The strip should be buried to a depth of not less than 50 cm.

*d.Rods:*

Rod electrodes are very economical and require no excavation for their installation. Because buried length is more important than diameter, the extensible, small-diameter copper rod has many advantages. It can, for instance, be driven into the ground so that the soil contact with the rod is close and definite. Extensible rods are of standard lengths and made from hard-drawn copper. They have a hardened steel tip and a steel driving cap. Sometimes the copper rod has a steel rod running through its centre for strength while it is being driven into rocky soil. Ribbed earth rods have wide vertical ribs to give a high degree of mechanical stiffness, so that they are not easily bent or deflected when driven into the ground.

Because the method used to connect the earthing lead to the earth electrode is important, all clamps and clips must conform to the requirements of the IEE Regulations.

The PME method gives protection against earth-fault conditions and uses the neutral of the incoming supply as the earth point or terminal. In this system of earthing, all protected metalwork is connected, by means of the installation CPCs, to the neutral-service conductor at the supply-intake position. By doing this, line-to-earth faults are converted into line-to-neutral faults. The reason for this is to ensure that sufficient current will flow under fault conditions to blow a fuse or trip an overload circuit-breaker, so isolating the faulty circuit from the supply.

Residual-current ELCBs are now only recognized by the Regulations. The basic principle of operation depends upon more current flowing into the live side of the primary winding than leaves by the neutral or other return (earth) conductor. The essential part of the residual-current ELCB is a transformer with opposed windings carrying the incoming and outgoing current. In a healthy circuit, where the values of current in the windings are equal, the magnetic effects cancel each other out. However, a fault will cause an out-of-balance condition and create a magnetic effect in the transformer core which links with the turns of a small secondary winding. An emf is induced in this winding. The secondary winding is permanently connected to the trip coil of the circuit-breaker. The induced emf will cause a current to flow in the trip coil:

If this current is of sufficient value the coil will become energized to trip the breaker contacts. A test switch is provided.

# CHAPTER SIX

# ILLUMINATION CALCULATIONS IN THIS PROJECT

You can see the illumination calculations at below, in this project while making calculations i used K-factor method for calculate common usage places illumination level and how to placing lambs with details.

## 6.1 Dinning Hall

A = Length of room =12.2m    B = Widht of room = 8.15m

Chosen illumination level  E = 75lux

Dirtiness Factor d =1.25

$h_1$ = 3.38 m ( Height of ceiling form ground)

$h_2$ = 0.85 m ( Height of working plane form ground)

$h_3$ = 0 m (Hanging distnace)

Ceiling is clear with value of  0.80

Wall is little dark with value of  0.50

Ground (floor) is dark with value of  0.30

$H = h_1 - ( h_2 + h_3 )$   $H = 3.38 - ( 0.85 + 0 )$   $H = 2.53m$

$K_{index}=(AxB)/(A+B)xH$    $K_{index}=(12.2x8.15) / (12.2+8.15) x 2.53 =1.9$

By interpolation

$y_2=y_1+[(x_2-x1)/(x_3-x_1)]+(y_3-y_1)$    $x_1=1.5$    $y_1=0.45$

$y_2=0.45+[(1.9-1.5)/(2.0-1.5)]+(0.51–0.45)$    $x_2=1.9$    $y_2= ?$

$y_2=0.5$    $x_3=2.0$    $y_3=0.51$

ØT =(AxBxExd)/$y_2$    ØT=(12.2x8.15x75x1.25) / 0.50    ØT=18634lm

Z=number of lambs at armature    Z=4

Type of lamps: T5 8W/54    ØA=330lm

n= number of lambs    n=ØT/ZxØA    n=18643/4x330≅ 15lambs

## 2 Kitchen

Length of room=10. B= Widht of room =5.10m

osen illumination level E=125lux

tiness Factor=d=1.25

=3.38 m ( Height of ceiling form ground)

=0.85 m ( Height of working plane form ground)

=0 m (Hanging distnace)

iling is clear with value of 0.80

all is little dark with value of 0.50

ound (floor) is dark with value of 0.30

$= h_1-(h_2+h_3)$ H=3.38 – (0.85+0) H=2.53m

$_{ndex}$=(AxB)/ (A+B)xH $K_{index}$=(10.0 x5.10)/ (10.0+5.10)x2.53=1.33

/ interpolation

| | | |
|---|---|---|
| $=y1+[(x_2-x_1)/(x_3-x_1)]+(y_3-y_1)$ | $x_1$=1.25 | $y_1$=0.41 |
| =0.41+[(1.33-1.25)/(1.5-1.25)]+(0.45-0.41) | $x_2$=1.33 | $y_2$= ? |
| =0.42 | $x_3$=1.50 | $y_3$=0.45 |

T =(AxBxExd)/y2 ØT=(10.0x5.10x125x1.25)/ 0.42 ØT=18973lm

=number of lambs at armature Z=4

ype of lamps: T5 13W/54 ØA=700lm

= number of lambs n=ØT/ZxØA n=18973/4x700≅ 6lambs

## .3 Study Room

.=Length of room=5.10. B= Widht of room =3.95m

Chosen illumination level E=150lux

Dirtiness Factor=d=1.25

$_1$=3.38 m ( Height of ceiling form ground)

$_2$=0.85 m ( Height of working plane form ground)

$_3$=0 m (Hanging distnace)

Ceiling is clear with value of 0.80

Wall is little dark with value of 0.50

Ground (floor) is dark with value of 0.30

$H = h_1-(h_2+h_3)$ $H=3.38-(0.85+0)$ $H=2.53m$

$K_{index} = (AxB)/ (A+B)xH$ $K_{index} = (5.10x3.95) / (5.10+3.95)x2.53 =0.87$

By interpolation

$y_2=y_1+[(x_2-x_1)/(x_3-x_1)]+(y_3-y_1)$ $x_1=0.80$ $y_1=0.31$

$y_2=0.31+[(0.87-0.80) /(1.0-0.80)]+(0.36-0.31)$ $x_2=0.87$ $y_2= ?$

$y_2=0.32$ $x_3=1.00$ $y_3=0.36$

ØT =(AxBxExd) / $y_2$ ØT=(5.10x3.95x150x1.25) / 0.32 ØT=11803lm

Z=number of lambs at armature Z=4

Type of lamps: T5 13W/54 ØA=700lm

n= number of lambs n=ØT/ZxØA n=11803/ 4x700≅ 4lambs

## . Multiple Purpose Room

Length of room=12.20. B= Widht of room =8.00m

osen illumination level E=200lux

rtiness Factor=d=1.25

=3.38 m ( Height of ceiling form ground)

=0.85 m ( Height of working plane form ground)

=0 m (Hanging distnace)

eiling is clear with value of 0.80

all is little dark with value of 0.50

round (floor) is dark with value of 0.30

$=h_1-(h_2+h_3)$ $H=3.38-(0.85+0)$ $H=2.53m$

$_{index}=(AxB)/ (A+B)x H$ $K_{index}=(12.20x8.00)/ (12.20+8.00) x2.53=1.90$

y interpolation

$_2=y_1+[(x_2-x_1)/(x_3-x_1)]+(y_3-y_1)$ $x_1=1.5$ $y_1=0.45$

$_2=0.45+[(1.9-1.5)/(2.0-1.5)]+(0.51-0.45)$ $x_2=1.9$ $y_2= ?$

$_2=0.5$ $x_3=2.0$ $y_3=0.51$

ØT =(AxBxExd)/$y_2$ ØT=(12.20 x8.00 x200x1.25) / 0.50 ØT=49795lm

Z=number of lambs at armature Z=4

Type of lamps: incandescent ØA=930lm

n= number of lambs n=ØT/ZxØA n=11803/ 6x930≅ 9lambs

## CONCLUSION

this project drawed complety electric project with high current medium current parts low current parts In this project drawed by using autocad drawing program

his projects main aim is making illumination calculations and putting lambs acourding to s and also calculating power at each line similarly putting sockets and telephone and vision sockets and also deciding on fuse tpes at distribution boxes

here are more complex Project in real life like hotles,airports hospital etc. but this project shows main logic of installation

he draw can be improved by adding some more equipments like ligtning rod camera allation and voice installation

# REFERENCES

Electrical wiring commercial book Ray C. Mullhin & Robert L.Smith

http://www.wikipedia.com

Lamps and lighting book Henderson & Marsden

Illumination technique book Prof. Dr. Muzaffer Özkaya

Electrical installation technology book F.G. Thompson