NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electricaland Electronic Engineering

ELECTRICAL INSTALLATION PROJECT

Graduation Project

EE-400

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ABSTRACT

The electrical insallation is one of the most important subject of an electrical engineering.According to this, the thesis is about an electrical installation of a home.

The main objective of this thesis is to provide an electrical insallation with AutoCAD. For this thesis AutoCAD is very important. Also, with the help of AutoCAD, you can easily draw the part of you installation project.

According to this thesis you can learn to use AutoCAD and also learn to make cost calculation and other calculations for electrical installation as well.

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INTRODUCTION

The thesis is about an electrical installation drawing.Electrical installation is very important for an engineering. So I decided to choose this subject, it will help me in my future carrier as well.In this thesis firstly I learn how I can design an electrical installation of the building .In addition to thesis, I also tried to provide an electrical installation with an AUTOCAD.

The first chapter is about Electricity and History of Electricity .I explain the Electricity and electricity's history.

The second chapter is about Electrical Drawing.I explain what is Light ? And light history and Lighting. And I explain Illumination Calculations.How we can calculate number of lamps and placement of the luminaries to the ceiling.

The third chapter is Voltage Drop. I explain voltage drope and I explain why is voltage drope important for installation.

The fourth chapter is about Ground.

The fifth chapter is about Cost Calculation. I show Price per Item and total cost.

1.ELECTRICITY REVIEW

1.1 ELECTRICITY

Electricity is a form of energy. Electricity is the flow of electrons. All matter is made up of atoms, and an atom has a center, called a nucleus. The nucleus contains positively charged particles called protons and uncharged particles called neutrons. The nucleus of an atom is surrounded by negatively charged particles called electrons. The negative charge of an electron is equal to the positive charge of a proton, and the number of electrons in an atom is usually equal to the number of protons. When the balancing force between protons and electrons is upset by an outside force, an atom may gain or lose an electron. When electrons are "lost" from an atom, the free movement of these electrons constitutes an electric current.

Electricity is a basic part of nature and it is one of our most widely used forms of energy. We get electricity, which is a secondary energy source, from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources. Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. Before electricity generation began slightly over 100 years ago, houses were lit with kerosene lamps, food was cooled in iceboxes, and rooms were warmed by wood-burning or coal-burning stoves. Beginning with Benjamin Franklin's experiment with a kite one stormy night in Philadelphia, the principles of electricity gradually became understood. In the mid-1800s, everyone's life changed with the inventionof the electric light bulb. Prior to 1879, electricity had been used in arc lights for outdoor lighting. The lightbulb's invention used electricity to bring indoor lighting to our homes.

1.2 TRANSFORMER

To solve the problem of sending electricity over long distances, George Westinghouse developed a device called a transformer. The transformer allowed electricity to be efficiently transmitted over long distances. This made it possible to supply electricity to homes and businesses located far from the electric generating plant.

Despite its great importance in our daily lives, most of us rarely stop to think what life would be like without electricity. Yet like air and water, we tend to take electricity for granted. Everyday, we use electricity to do many functions for us -- from lighting and heating/cooling our homes, to being the power source for televisions and computers. Electricity is a controllable and convenient form of energy used in the applications of heat, light and power.

Today, the United States (U.S.) electric power industry is organized to ensure that an adequate supply of electricity is available to meet all demand requirements at any given instant.

1.3 GENERATOR

An electric generator is a device for converting mechanical energy into electrical energy. The process is based on the relationship between magnetism and electricity. When a wire or any other electrically conductive material moves across a magnetic field, an electric current occurs in the wire. The large generators used by the electric utility industry have a stationary conductor. A magnet attached to the end of a rotating shaft is positioned inside a stationary conducting ring that is wrapped with a long, continuous piece of wire. When the magnet rotates, it induces a small electric current in each section of wire as it passes. Each section of wire constitutes a small, separate electric conductor. All the small currents of individual sections add up to one current of considerable size. This current is what is used for electric power.

1.4 TURBINE USED TO GENERATE ELECTRICITY

An electric utility power station uses either a turbine, engine, water wheel, or other similar machine to drive an electric generator or a device that converts mechanical or chemical energy to electricity. Steam turbines, internal-combustion engines, gas combustion turbines, water turbines, and wind turbines are the most common methods to generate electricity.

Most of the electricity in the United States is produced in steam turbines. A turbine converts the kinetic energy of a moving fluid (liquid or gas) to mechanical energy. Steam turbines have a series of blades mounted on a shaft against which steam is forced, thus rotating the shaft connected to the generator. In a fossil-fueled steam turbine, the fuel is burned in a furnace to heat water in a boiler to produce steam.

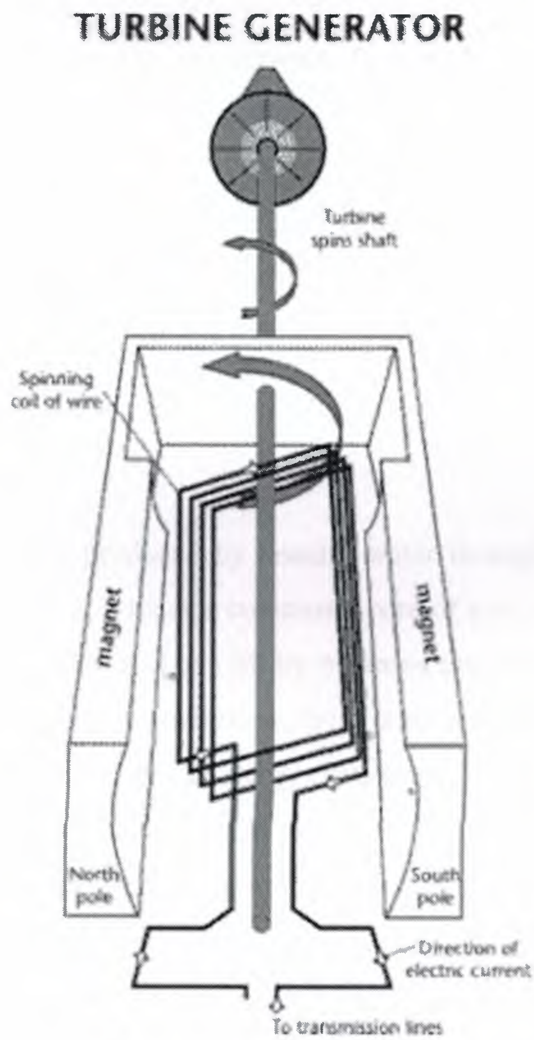

Figure 1.4 Turbıne Generator

1.5 OTHER GENERATING SOURCES

✓ **Coal, Petroleum (oil), and Natural Gas**

are burned in large furnaces to heat water to make steam that in turn pushes on the blades of a turbine. Did you know that coal is the largest single primary source of energy used to generate electricity in the United States? In 1998, more than half (52%) of the county's 3.62 trillion kilowatthours of electricity used coal as its source of energy.

✓ **Natural Gas,**

in addition to being burned to heat water for steam, can also be burned to produce hot combustion gases that pass directly through a turbine, spinning the blades of the turbine to generate electricity. Gas turbines are commonly used when electricity utility usage is in high demand. In 1998, 15% of the nation's electricity was fueled by natural gas.

✓ **Petroleum**

can also be used to make steam to turn a turbine. Residual fuel oil, a product refined from crude oil, is often the petroleum product used in electric plants that use petroleum to make steam. Petroleum was used to generate less than three percent (3%) of all electricity generated in U.S. electricity plants in 1998.

✓ **Nuclear Power**

is a method in which steam is produced by heating water through a process called nuclear fission. In a nuclear power plant, a reactor contains a core of nuclear fuel, primarily enriched uranium. When atoms of uranium fuel are hit by neutrons they fission (split), releasing heat and more neutrons. Under controlled conditions, these other neutrons can strike more uranium atoms, splitting more atoms, and so on. Thereby, continuous fission can take place, forming a chain reaction releasing heat. The heat is used to turn water into steam, that, in turn, spins a turbine that generates electricity. Nuclear power is used to generate 19% of all the country's electricity.

- ✓ **Hydropower**,

the source for 9% of U.S. electricity generation, is a process in which flowing water is used to spin a turbine connected to a generator. There are two basic types of hydroelectric systems that produce electricity. In the first system, flowing water accumulates in reservoirs created by the use of dams. The water falls through a pipe called a penstock and applies pressure against the turbine blades to drive the generator to produce electricity. In the second system, called run-of-river, the force of the river current (rather than falling water) applies pressure to the turbine blades to produce electricity.

- ✓ **Geothermal Power**

comes from heat energy buried beneath the surface of the earth. In some areas of the country, magma (molten matter under the earth's crust) flows close enough to the surface of the earth to heat underground water into steam, which can be tapped for use at steam-turbine plants. This energy source generates less than 1% of the electricity in the country.

- ✓ **Solar Power**

is derived from the energy of the sun. However, the sun's energy is not available full-time and it is widely scattered. The processes used to produce electricity using the sun's energy have historically been more expensive than using conventional fossil fuels. Photovoltaic conversion generates electric power directly from the light of the sun in a photovoltaic (solar) cell. Solar-thermal electric generators use the radiant energy from the sun to produce steam to drive turbines. Less than 1% of the nation's electricity is based on solar power.

- ✓ **Wind Power**

is derived from the conversion of the energy contained in wind into electricity. Wind power like the sun, is usually an expensive source of producing electricity, and is used for less than 1% of the nation's electricity. A wind turbine is similar to a typical wind mill.

- ✓ **Biomass**

wood, municipal solid waste (garbage), and agricultural waste, such as corn cobs and wheat straw, are some other energy sources for producing electricity. These sources replace fossil fuels in the boiler.

1.6 BASIC UNITS OF ELECTRICITY

1.6.1 Electric Charge

The presence of charge gives rise to an electrostatic force: charges exert a force on each other, an effect that was known, though not understood, in antiquity.A lightweight ball suspended from a string can be charged by touching it with a glass rod that has itself been charged by rubbing with a cloth. If a similar ball is charged by the same glass rod, it is found to repel the first: the charge acts to force the two balls apart. Two balls that are charged with a rubbed amber rod also repel each other. However, if one ball is charged by the glass rod, and the other by an amber rod, the two balls are found to attract each other. These phenomena were investigated in the late eighteenth century by Charles-Augustin de Coulomb, who deduced that charge manifests itself in two opposing forms. This discovery led to the well-known axiom: like-charged objects repel and opposite-charged objects attract.

The force acts on the charged particles themselves, hence charge has a tendency to spread itself as evenly as possible over a conducting surface. The magnitude of the electromagnetic force, whether attractive or repulsive, is given by Coulomb's law, which relates the force to the product of the charges and has an inverse-square relation to the distance between them.The electromagnetic force is very strong, second only in strength to the strong interaction, but unlike that force it operates over all distances. In comparison with the much weaker gravitational force, the electromagnetic force pushing two electrons apart is 1042 times that of the gravitational attraction pulling them together.

Study has shown that the origin of charge is from certain types of subatomic particles which have the property of electric charge. Electric charge gives rise to and interacts with the electromagnetic force, one of the four fundamental forces of nature. The most familiar carriers of electrical charge are the electron and proton. Experiment has shown charge to be a conserved quantity, that is, the net charge within an isolated system will always remain constant regardless of any changes taking place within that system. Within the system, charge may be transferred between bodies, either by direct contact, or by passing along a conducting material, such as a wire. The informal term static electricity refers to the net presence (or 'imbalance') of charge on a body, usually caused when dissimilar materials are rubbed together, transferring charge from one to the other.

The charge on electrons and protons is opposite in sign, hence an amount of charge may be expressed as being either negative or positive. By convention, the charge carried by electrons is deemed negative, and that by protons positive, a custom that originated with the work of Benjamin Franklin. The amount of charge is usually given the symbol Q and expressed in coulombs; each electron carries the same charge of approximately $-1.6022\times10-19$ coulomb. The proton has a charge that is equal and opposite, and thus $+1.6022\times10-19$ coulomb. Charge is possessed not just by matter, but also by antimatter, each antiparticle bearing an equal and opposite charge to its corresponding particle.

Charge can be measured by a number of means, an early instrument being the gold-leaf electroscope, which although still in use for classroom demonstrations, has been superseded by the electronic electrometer.

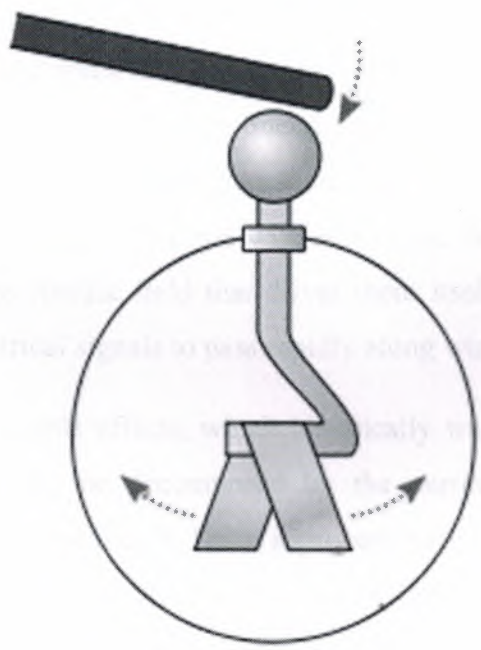

Figure 1.6.1 Charge on a gold-leaf electroscope causes the leaves to visibly repel each other

1.6.2 Electric current

The movement of electric charge is known as an electric current, the intensity of which is usually measured in amperes. Current can consist of any moving charged particles; most commonly these are electrons, but any charge in motion constitutes a current.

By historical convention, a positive current is defined as having the same direction of flow as any positive charge it contains, or to flow from the most positive part of a circuit to the most negative part. Current defined in this manner is called conventional current. The motion of negatively charged electrons around an electric circuit, one of the most familiar forms of current, is thus deemed positive in the opposite direction to that of the electrons.However, depending on the conditions, an electric current can consist of a flow of charged particles in either direction, or even in both directions at once. The positive-to-negative convention is widely used to simplify this situation.

The process by which electric current passes through a material is termed electrical conduction, and its nature varies with that of the charged particles and the material through which they are travelling. Examples of electric currents include metallic conduction, where electrons flow through a conductor such as metal, and electrolysis, where ions (charged atoms) flow through liquids, or through plasmas such as electrical sparks. While the particles themselves can move quite slowly, sometimes with an average drift velocity only fractions of a millimetre per second, the electric field that drives them itself propagates at close to the speed of light, enabling electrical signals to pass rapidly along wires.

Current causes several observable effects, which historically were the means of recognising its presence. That water could be decomposed by the current from a voltaic pile was discovered by Nicholson and Carlisle in 1800, a process now known as electrolysis. Their work was greatly expanded upon by Michael Faraday in 1833. Current through a resistance causes localised heating, an effect James Prescott Joule studied mathematically in 1840.One of the most important discoveries relating to current was made accidentally by Hans Christian Ørsted in 1820, when, while preparing a lecture, he witnessed the current in a wire disturbing the needle of a magnetic compass.He had discovered electromagnetism, a fundamental interaction between electricity and magnetics. The level of electromagnetic emissions generated by electric arcing is high enough to produce electromagnetic interference, which can be detrimental to the workings of adjacent equipment.

In engineering or household applications, current is often described as being either direct current (DC) or alternating current (AC). These terms refer to how the current varies in time. Direct current, as produced by example from a battery and required by most electronic devices, is a unidirectional flow from the positive part of a circuit to the negative.If, as is most common, this flow is carried by electrons, they will be travelling in the opposite direction. Alternating current is any current that reverses direction repeatedly; almost always this takes the form of a sine wave.Alternating current thus pulses back and forth within a conductor without the charge moving any net distance over time. The time-averaged value of an alternating current is zero, but it delivers energy in first one direction, and then the reverse. Alternating current is affected by electrical properties that are not observed under steady state direct current, such as inductance and capacitance.These properties however can become important when circuitry is subjected to transients, such as when first energised.

1.6.3 Electric Potential

The concept of electric potential is closely linked to that of the electric field. A small charge placed within an electric field experiences a force, and to have brought that charge to that point against the force requires work. The electric potential at any point is defined as the energy required to bring a unit test charge from an infinite distance slowly to that point. It is usually measured in volts, and one volt is the potential for which one joule of work must be expended to bring a charge of one coulomb from infinity.This definition of potential, while formal, has little practical application, and a more useful concept is that of electric potential difference, and is the energy required to move a unit charge between two specified points. An electric field has the special property that it is conservative, which means that the path taken by the test charge is irrelevant: all paths between two specified points expend the same energy, and thus a unique value for potential difference may be stated. The volt is so strongly identified as the unit of choice for measurement and description of electric potential difference that the term voltage sees greater everyday usage.

For practical purposes, it is useful to define a common reference point to which potentials may be expressed and compared. While this could be at infinity, a much more useful reference is the Earth itself, which is assumed to be at the same potential everywhere. This reference point naturally takes the name earth or ground. Earth is assumed to be an infinite source of equal amounts of positive and negative charge, and is therefore electrically uncharged—and unchargeable.

Electric potential is a scalar quantity, that is, it has only magnitude and not direction. It may be viewed as analogous to height: just as a released object will fall through a difference in heights caused by a gravitational field, so a charge will 'fall' across the voltage caused by an electric field. As relief maps show contour lines marking points of equal height, a set of lines marking points of equal potential (known as equipotentials) may be drawn around an electrostatically charged object. The equipotentials cross all lines of force at right angles. They must also lie parallel to a conductor's surface, otherwise this would produce a force that will move the charge carriers to even the potential of the surface.

The electric field was formally defined as the force exerted per unit charge, but the concept of potential allows for a more useful and equivalent definition: the electric field is the local gradient of the electric potential. Usually expressed in volts per metre, the vector direction of the field is the line of greatest slope of potential, and where the equipotentials lie closest together.

1.6.4 Electric Field

The concept of the electric field was introduced by Michael Faraday. An electric field is created by a charged body in the space that surrounds it, and results in a force exerted on any other charges placed within the field. The electric field acts between two charges in a similar manner to the way that the gravitational field acts between two masses, and like it, extends towards infinity and shows an inverse square relationship with distance. However, there is an important difference. Gravity always acts in attraction, drawing two masses together, while the electric field can result in either attraction or repulsion. Since large bodies such as planets generally carry no net charge, the electric field at a distance is usually zero. Thus gravity is the dominant force at distance in the universe, despite being much weaker.

An electric field generally varies in space, and its strength at any one point is defined as the force (per unit charge) that would be felt by a stationary, negligible charge if placed at that point.The conceptual charge, termed a 'test charge', must be vanishingly small to prevent its own electric field disturbing the main field and must also be stationary to prevent the effect of magnetic fields. As the electric field is defined in terms of force, and force is a vector, so it follows that an electric field is also a vector, having both magnitude and direction. Specifically, it is a vector field.

The study of electric fields created by stationary charges is called electrostatics. The field may be visualised by a set of imaginary lines whose direction at any point is the same as that of the field. This concept was introduced by Faraday, whose term 'lines of force' still sometimes sees use. The field lines are the paths that a point positive charge would seek to make as it was forced to move within the field; they are however an imaginary concept with no physical existence, and the field permeates all the intervening space between the lines. Field lines emanating from stationary charges have several key properties: first, that they originate at positive charges and terminate at negative charges; second, that they must enter any good conductor at right angles, and third, that they may never cross nor close in on themselves.

A hollow conducting body carries all its charge on its outer surface. The field is therefore zero at all places inside the body.This is the operating principal of the Faraday cage, a conducting metal shell which isolates its interior from outside electrical effects.

The principles of electrostatics are important when designing items of high-voltage equipment. There is a finite limit to the electric field strength that may be withstood by any medium. Beyond this point, electrical breakdown occurs and an electric arc causes flashover between the charged parts. Air, for example, tends to arc across small gaps at electric field strengths which exceed 30 kV per centimetre. Over larger gaps, its breakdown strength is weaker, perhaps 1 kV per centimetre. The most visible natural occurrence of this is lightning, caused when charge becomes separated in the clouds by rising columns of air, and raises the electric field in the air to greater than it can withstand. The voltage of a large lightning cloud may be as high as 100 MV and have discharge energies as great as 250 kWh.

The field strength is greatly affected by nearby conducting objects, and it is particularly intense when it is forced to curve around sharply pointed objects. This principle is exploited in the lightning conductor, the sharp spike of which acts to encourage the lightning stroke to develop there, rather than to the building it serves to protect.

2. ELECTRICAL DRAWING

An electrical drawing, is a type of technical drawing that shows information about power, lighting, and communication for an engineering or architectural project. Any electrical working drawing consists of "lines, symbols, dimensions, and notations to accurately convey an engineering's design to the workers, who install the electrical system on the job".A complete set of working drawings for the average electrical system in large projects usually consists of :

- ✓ A plot plan showing the building's location and outside electrical wiring
- ✓ Floor plans showing the location of electrical systems on every floor
- ✓ Power-riser diagrams showing panel boards
- ✓ Control wiring diagrams
- ✓ Schedules and other information in combination with construction drawings.

Electrical drafters prepare wiring and layout diagrams used by workers who erect, install, and repair electrical equipment and wiring in communication centers, power plants, electrical distribution systems, and buildings.

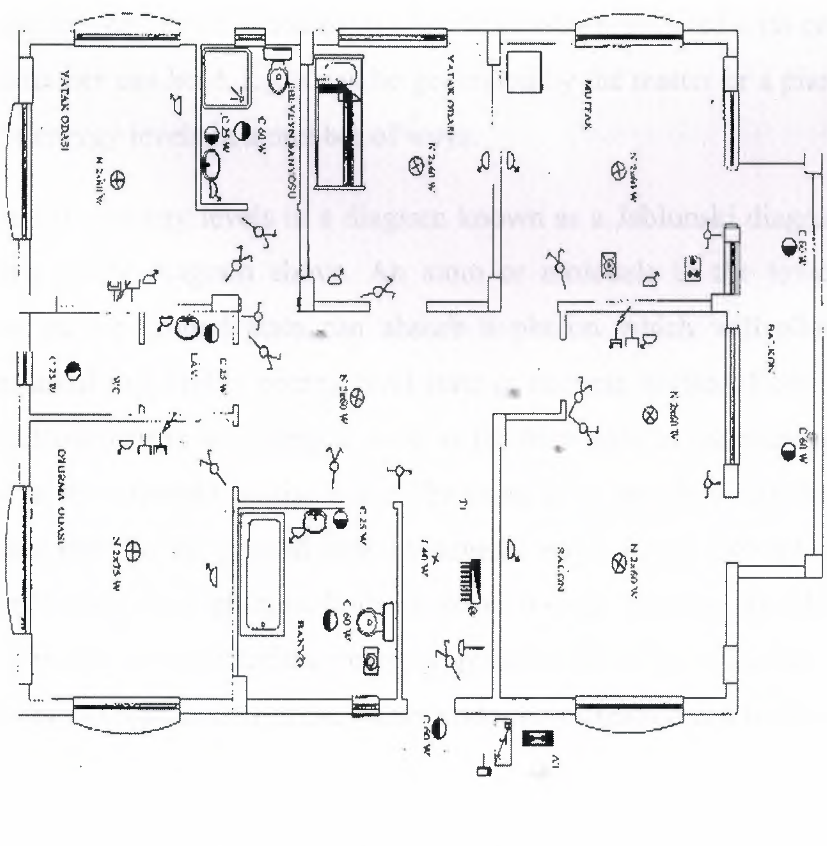

Figure 2 Electrical Drawing

2.1 LIGHT

Light is part of the electromagnetic spectrum, which ranges from radio waves to gamma rays. Electromagnetic radiation waves, as their names suggest are fluctuations of electric and magnetic fields, which can transport energy from one location to another. Visible light is not inherently different from the other parts of the electromagnetic spectrum with the exception that the human eye can detect visible waves. Electromagnetic radiation can also be described in terms of a stream of photons which are massless particles each travelling with wavelike properties at the speed of light. A photon is the smallest quantity (quantum) of energy which can be transported and it was the realization that light travelled in discrete quanta that was the origins of Quantum Theory.

It is no accident that humans can 'see' light. The detection of light is a very powerful tool for probing the universe around us. As light interacts with matter it can be become altered and by studying light that has originated or interacted with matter, many of the properties of that matter can be determined. It is through the study of light that.

Matter is composed of atoms, ions or molecules and it is light's interaction with matter which gives rise to the various phenomena which can help us understand the nature of matter. The atoms, ions or molecules have defined energy levels usually associated with energy levels that electrons in the matter can hold. Light can be generated by the matter or a photon of light can interact with the energy levels in a number of ways.

We can represent the energy levels in a diagram known as a Jablonski diagram. An example of one is shown in the diagram above. An atom or molecule in the lowest energy state possible known as the ground state can absorb a photon which will allow the atom or molecule to be raised to a higher energy level state or become excited. Hence the matter can absorb light of characteristic wavelengths such as the blue light in the example on the left or the violet light in the example on the right. The atom or molecule won't stay in an excited state so it relaxes back to the ground state by several ways. In the example on the left, the atom or molecule emits two photons both of lower energy that the absorbed photon. The photons emitted will be a characteristic energy appropriate for a particular atom or compound and so by studying the light emission the matter under investigation can be determined.

2.2 LIGHTING

There are some important questions that should be considered when planning a new project, specifically: Is "good" illumination important to your project? What is good lighting design and how is it achieved?

Light is a technically difficult yet astonishing medium that requires mastery of varied and continually evolving disciplines. A lighting design practice integrates the arts, sciences and business of illumination design and implementation far beyond concerns of visibility and horizontal footcandles.

Lighting designers work as part of a design team and, like architects, charge fees for services rendered. Professional lighting designers bring solid technical acumen and sensitive design technique to architectural and landscape projects. But the value-added services they provide can make or break the success of a project and, therefore, outweigh, the impact of their fee.

Illumination is the ephemeral partner of architecture. Light is invisible until it strikes an object or surface. And it is controlling this difficult, transitory medium that gives the lighting "artist" the ability to create hierarchies, dynamics and mood. Lighting design has become a creative extension of architectural design, improving visibility and complementing form, program and color. Experience and, of course, talent create patterns of illumination that seamlessly support overall project goals.

Knowledge of physics, optics, electricity, ergonomics, business, codes, environmental issues, construction, vision and the art of design are all essential to creating great lighting solutions. Lighting professionals must be well grounded and continually educate themselves to provide the best possible service. They do so in many ways including networking, reading trade magazines and journals, attending and presenting seminars. This sort of give and take, along with healthy competition, forwards the profession as a whole.

2.2.1 ILLUMINATION CALCULATION AND DESIGN

The quantity of light reaching a certain surface is usually the main consideration in designing a lighting system.

This quantity of light is specified by illuminance measured in lux, and as this level varies across the working plane, an average figure is used.

COLORS	REFLECTION FACTOR%	MATERIAL	REFLECTION FACTOR %
Black	3-7	Dark wood	10-25
Dark blue	5-15	Dark bricks	15-25
Dark brown	10-20	Granite	15-25
Dark red	10-20	Pale bricks	30-50
Dark green	10-20	Clear wood	30-50
Pale brown	30-40	Opaque aluminum	55-60
Light red	30-50	Burnished steel	55-65
Light blue	40-55	White marble	60-70
Pink	45-55	Polished aluminum	
Light green	45-65	Aluminum	80-85
Beige, light yellow	50-75	Mirror, silver-plated glass	80-90

Figure 2.2.1 Reflection factors of surfaces colours and materials

Ceiling	0.80				0.50				0.30	
Wall	0.50		0.30		0.50		0.30		0.10	0.30
Floor	0.30	0.10	0.30	0.10	0.30	0.10	0.30	0.10	0.10	0.10
$k = \frac{axb}{hx(a+b)}$	efficiency (η)									
0.60	0.24	0.23	0.18	0.18	0.20	0.19	0.15	0.15	0.12	0.15
0.80	0.31	0.29	0.24	0.23	0.25	0.24	0.20	0.19	0.16	0.17
1.00	0.36	0.33	0.29	0.28	0.29	0.28	0.24	0.23	0.20	0.20
1.25	0.41	0.38	0.34	0.32	0.33	0.31	0.28	0.27	0.24	0.24
1.50	0.45	0.41	0.38	0.36	0.36	0.34	0.32	0.30	0.27	0.26
2.00	0.51	0.46	0.45	0.41	0.41	0.38	0.37	0.35	0.31	0.30
2.50	0.56	0.49	0.50	0.45	0.45	0.41	0.41	0.38	0.35	0.34
3.00	0.59	0.52	0.54	0.48	0.47	0.43	0.43	0.40	0.38	0.36
4.00	0.63	0.55	0.58	0.51	0.50	0.46	0.47	0.44	0.41	0.39
5.00	0.66	0.57	0.62	0.54	0.53	0.48	0.50	0.46	0.44	0.40

Figure 2.2.2 Efficiency of Illumination

■ RECOMMENDED ILLUMINATON:

OFFICE	Conference, reception room	200~750Lux
	Clerical work	700~1,500Lux
	Typing drafting	1,000~2,000Lux
FACTORY	Packing work, entrance passage	150~300Lux
	Visual work at production line	300~750Lux
	Inspection work	750~1,500Lux
	Electronic parts assembly line	1,500~3,000Lux
HOTEL	Public room, cloakroom	100~200Lux
	Reception, cashier	220~1,000Lux
STORE	Indoors stairs corridor	150~200Lux
	Show window, packing table	750~1,500
	Forefront of show window	1,500~3,000
HOSPITAL	Sickroom, warehouse	100~200Lux
	Medical examination room	300~750Lux
	Operation room, emergency treatment	750~1,500Lux
SCHOOL	Auditorium, indoor gymnasium	100~300Lux
	Class room	200~750Lux
	Laboratory, library, drafting room	500~1,500Lux

Figure 2.2.3 Illuminate the General Lux Table

Distinctive	LED	Mercury	HPS	LPS	Metal Halide	Incandescent
Power (W)	30 - 60	50 - 400	35 - 1000	18 - 180	400 - 1000	10 - 1000
Lifetime (h)	100,000	2500 - 5000	8000 - 24000	2000 - 3000	2000	1000
V Variation at Flux	None	>	>	>	>	>
Shock Resistance	> 97%	~75%	~75%	~85%	~75%	~20%
Luminous Efficiency (lm\w)	30 - 50	30 - 50	50 - 100	80 - 180	60 - 80	5 - 20
Start Time (m)	Immediate	~7	~7	~10	~5	Immediate
Restart Time (m)	Immediate	~10	~10	~3	~10	Immediate
Stroboscopic Effect	Absent	Present	Present	Present	Present	Present

Figure 2.2.4 Several power and luminous flux of lamps table

$$k = \frac{a.b}{H.(a+b)}$$

k =index(usage factor)

a=Width of the room

b=Length of the room

H=work plane $\mathbf{H = h - (h_1 + h_2)}$

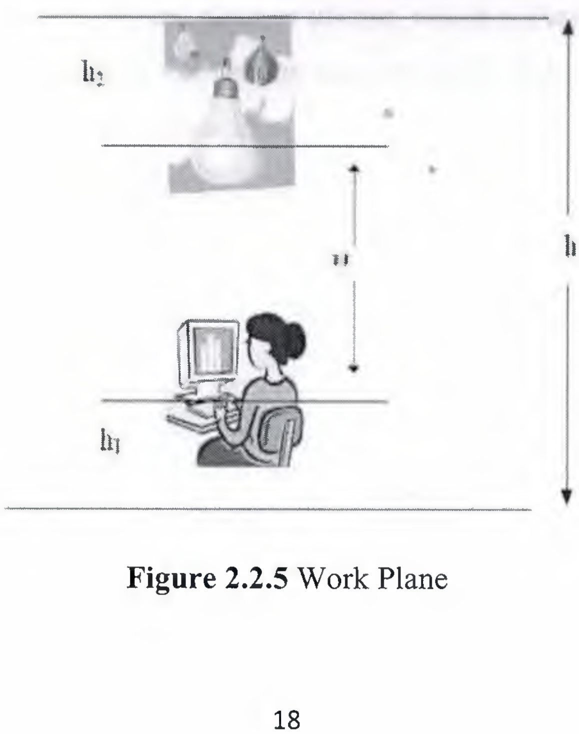

Figure 2.2.5 Work Plane

$$\theta t = \frac{d.E.A}{n}$$ θt=Total light flux n=Efficiency

A= Area of the medium to be illuminated

E=Illumination level d= dirt factor

$$N = \frac{\theta t}{\theta l * Z}$$ N=Number of lamps

$\theta\ell$=Light flux of the lamp

Z=Number of lamps per luminarie

2.3 LAMP

The first lamp was invented around 70,000 BC. A hollow rock, shell or other natural found object was filled with moss or a similar material that was soaked with animal fat and ignited. Humans began imitating the natural shapes with manmade pottery, alabaster, and metal lamps. Wicks were later added to control the rate of burning. Around the 7th century BC, the Greeks began making terra cotta lamps to replace handheld torches. The word lamp is derived from the Greek word lampas, meaning torch. A lamp is a replaceable component such as an incandescent light bulb,which is designed to produce light from electricity. These components usually have a base of ceramic, metal, glass or plastic, which makes an electrical connection in the socket of a light fixture.This connection may be made with a screw-thread base, two metal pins,two metal caps or a bayonet cap.

- ✓ Incandescent lamp
- ✓ Halogen lamp
- ✓ Gas-discharge lamp
- ✓ Fluorescent lamp
- ✓ LED lamp
- ✓ OLED lamp
- ✓ Neon lamp

2.3.1 Incandescent Lamp

An incandescent light bulb, incandescent lamp or incandescent light globe is an electric light which produces light with a wire filament heated to a high temperature by an electric current passing through it, until it glows (see Incandescence). The hot filament is protected from oxidation with a glass or quartz bulb that is filled with inert gas or evacuated. In a halogen lamp, filament evaporation is prevented by a chemical process that redeposits metal vapor onto the filament, extending its life. The light bulb is supplied with electrical current by feed-through terminals or wires embedded in the glass. Most bulbs are used in a socket which provides mechanical support and electrical connections.

Incandescent bulbs are manufactured in a wide range of sizes, light output, and voltage ratings, from 1.5 volts to about 300 volts. They require no external regulating equipment, have low manufacturing costs, and work equally well on either alternating current or direct current. As a result, the incandescent lamp is widely used in household and commercial lighting, for portable lighting such as table lamps, car headlamps, and flashlights, and for decorative and advertising lighting.

Incandescent bulbs are much less efficient than most other types of electric lighting; incandescent bulbs convert less than 5% of the energy they use into visible light (with the remaining energy being converted into heat). The luminous efficacy of a typical incandescent bulb is 16 lumens per watt, compared to the 60 lm/W of a compact fluorescent bulb. Some applications of the incandescent bulb deliberately use the heat generated by the filament. Such applications include incubators, brooding boxes for poultry, heat lights for reptile tanks, infrared heating for industrial heating and drying processes, lava lamps, and the Easy-Bake Oven toy. Incandescent bulbs also have short lifetimes compared with other types of lighting; around 1000 hours for home light bulbs versus up to 10,000 hours for compact fluorescents and up to 100,000 hours for LED lamps.

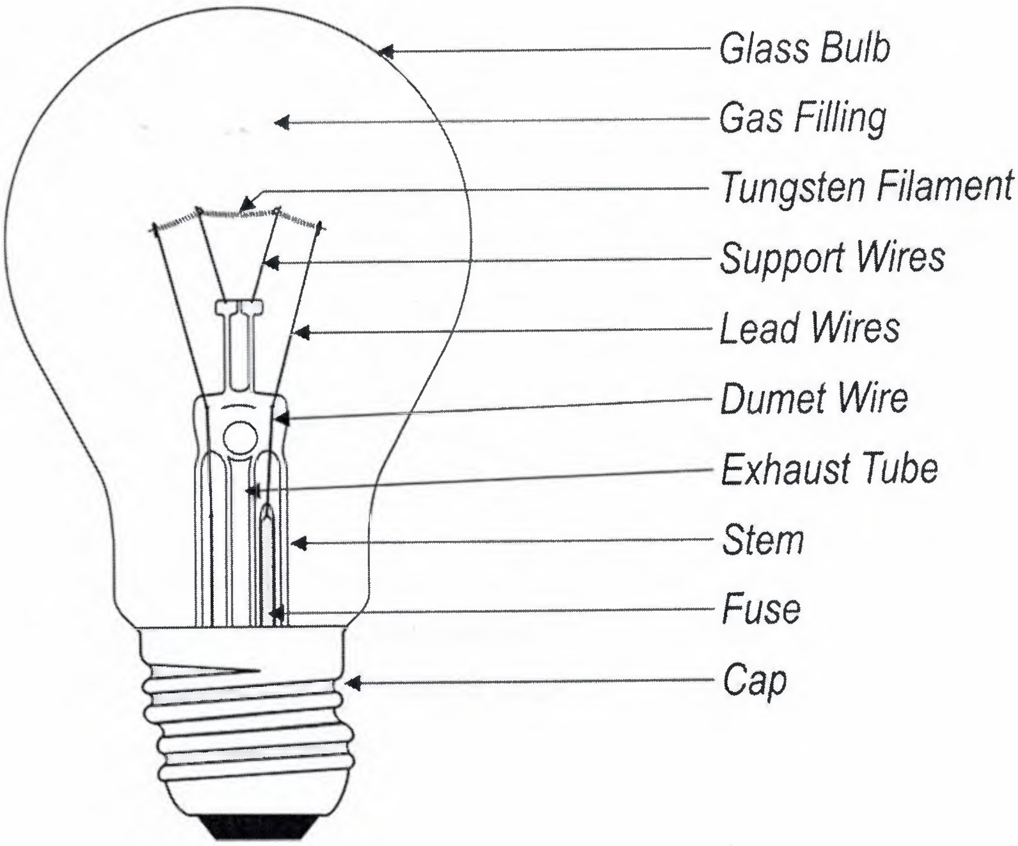

Figure 2.3.1 A Typical Incandescent Lamp

2.3.2 Halogen Lamp

A carbon filament lamp using chlorine to prevent darkening of the envelope was patented in 1882, and chlorine-filled "NoVak" lamps were marketed in 1892. The use of iodine was proposed in a 1933 patent, which also described the cyclic redeposition of tungsten back onto the filament. In 1959, General Electric patented a practical lamp using iodine.

The halogen lamp is also known as a quartz halogen and tungsten halogen lamp. It is an advanced form of incandescent lamp. The filament is composed of ductile tungsten and located in a gas filled bulb just like a standard tungsten bulb, however the gas in a halogen bulb is at a higher pressure (7-8 ATM). The glass bulb is made of fused quartz, high-silica glass or aluminosilicate. This bulb is stronger than standard glass in order to contain the high pressure. This lamp has been an industry standard for work lights and film/television lighting due to compact size and high lumen output. The halogen lamp is being replaced slowly by the white LED array lamp, miniature HID and fluorescent lamps. Increased efficiency halogens with 30+ lumens per watt may change sale decline in the future.

The halogen lamp has a tungsten filament similar to the standard incandescent lamp, however the lamp is much smaller for the same wattage, and contains a halogen gas in the bulb. The halogen is important in that is stops the blackening and slows the thinning of the tungsten filament. This lengthens the life of the bulb and allows the tungsten to safely reach higher temperatures (therefore makes more light). The bulb must be able to stand higher temperatures so fused quartz is often used instead of normal silica glass.

A halogen is a monovalent element which readily forms negative ions. There are 5 halogens: fluorine, chlorine, bromine, iodine, and astatine. Only Iodine and Bromine are used in halogen tungsten lamps.

The lamp is turned on and the filament begins to glow red as more current passes through it. The temperature rapidly increases. The halogens boil to a gas at relatively low temperatures: Iodine (184 C) or Bromine (59 C). Normally tungsten atoms evaporate off of the filament and deposit on the inside of the bulb, this blackens normal incandescent lamps. As atoms leave the filament the filament gets thinner. Eventually the filament breaks (usually at the ends of the filament). In a halogen tungsten lamp the tungsten atoms chemically unite with the halogen gas molecules and when the halogen cools, the tungsten is redeposited back on the filament. This process is called the halogen cycle.

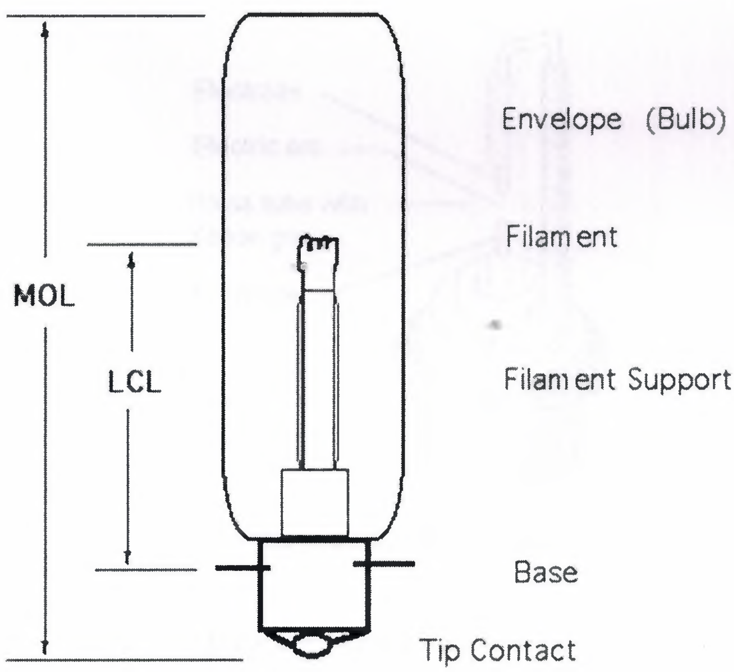

Figure 2.3.2 Halogen lamp

2.3.3 Gas-Discharge Lamp

The story begins back in 1675, when a French astronomer named Jean-Felix Picard made a remarkable observation. He was carrying a mercury barometer, when he noticed that the empty-space glowed as the mercury jiggled. Many people tried to explain this phenomenon, among which an English scientist named Francis Hauksbee, who was the first to demonstrate a gas-discharge lamp in 1705, operated with static electricity. 100 years later, Vasily V. Petrov, a Russian self-taught electrical technician described for the first time the phenomenon of electrical arc, which was a kick start to research extensively different kinds of discharge light sources.

A gas discharge lamp is a light source that generates light by creating an electrical discharge through an ionized gas. There are many different types of lamps that operate under this principle. Commonly, we separate them in 3 basic categories: High pressure discharge lamps, Low pressure discharge lamps and High-intensity discharge lamps.

These lamps have pressurized gas inside the tube, with higher pressure than the atmospheric pressure. Some examples of high pressure discharge lamps is are the metal halide lamps, the high pressure sodium lamps and the high pressure mercury-vapor lamps which are are very old, being replaced in most applications

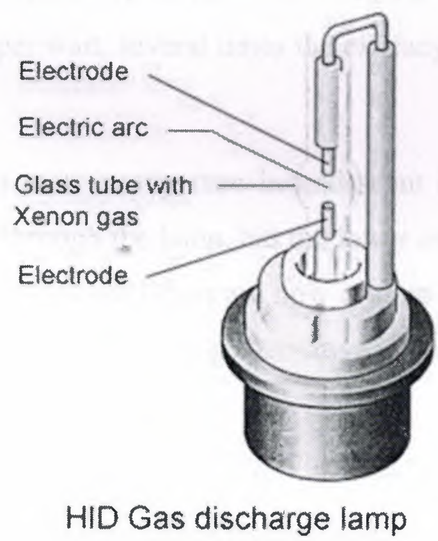

Figure 2.3.3 Gas Discharge Lamp

2.3.4 Fluorescent Lamp

Fluorescents are a large family of light sources. There are three main types of fluorescent lamps: cold cathode, hot cathode, and electroluminescent. They all use phosphors excited by electrons to create light. On this page we will discuss the cold and hot cathode lamps. Electroluminescent lamps use "fluorescence" but are so different they are covered on another page. From this point when we refer to 'fluorescent lamp' we will be talking about a lamp with a glass discharge tube and fluorescent coating on the inside, this is how the cold and hot cathode type of lamps are designed. Induction lamps are a form of fluorescent lamps but they don't have electrodes. We have a separate page for them here.

The standard fluorescent lamp was developed for commercial use during the 1930's. The idea of the fluorescent lamp had been around since the 1880's however it took steady work over the decades to finally create a working commercially viable model. This work was done by many, not one single inventor. See our inventors list to learn more.

A fluorescent lamp or fluorescent tube is a low pressure mercury-vapor gas-discharge lamp that uses fluorescence to produce visible light. An electric current in the gas excites mercury vapor which produces short-wave ultraviolet light that then causes a phosphor coating on the inside of the bulb to glow. A fluorescent lamp converts electrical energy into useful light much more efficiently than incandescent lamps. The luminous efficacy of a fluorescent light bulb can exceed 100 lumens per watt, several times the efficacy of an incandescent bulb with comparable light output.

Fluorescent lamp fixtures are more costly than incandescent lamps because they require a ballast to regulate the current through the lamp, but the lower energy cost typically offsets the higher initial cost. Compact fluorescent lamps are now available in the same popular sizes as incandescents and are used as an energy-saving alternative in homes.

Advantages

-Energy efficient, so far the best light for interior lighting

-Low production cost (of tubes, not of the ballasts)

-Long life of tubes

-Good selection of desired color temperature (cool whites to warm whites)

-Diffused Light (good for general, even lighting, reducing harsh shadows)

Disadvantages

-Flicker of the high frequency can be irritating to humans (eye strain, headaches, migraines)

-Flicker of common fluorescent light looks poor on video, and creates an ugly greenish or yellow hue on camera

-Diffused Light (not good when you need a focused beam such as in a headlight or flashlight)

-Poorly/cheaply designed ballasts can create radio interference that disturbs other electronics

-Poorly/cheaply designed ballasts can create fires when they overheat

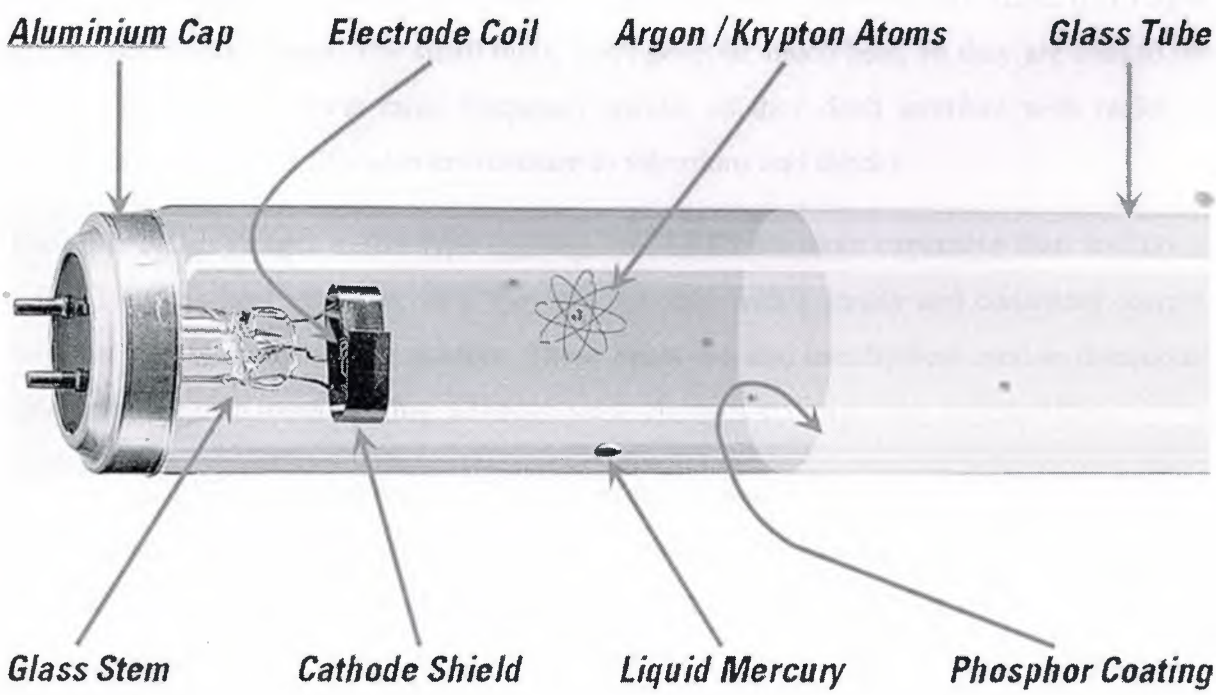

Figure 2.3.4 Fluorescent Lamp

2.3.5 LED lamp

LED lighting is a lamp or other light that uses light-emitting diodes (LEDs) as a source of illumination. Most lighting comes from an incandescent or fluorescent light bulb. Although they are different than the traditional bulb, LED bulbs are available that can be put into traditional lamps and used like most other light bulbs. They are much more efficient than incandescent or fluorescent options, however.

Light-emitting diodes are semiconductor devices that convert electricity to light by using the movement of electrons. They were invented in Russia in the 1920s and put into practical use in the United States in the 1960s by General Electric. In the late 1960s, Monsanto Corporation was the first to mass-produce LEDs, and Hewlett-Packard used them in its early calculators.

There are many consumer advantages to LEDs over incandescent or fluorescent light bulbs. LED lights consume much less energy: they are 300% more efficient than compact fluorescent lights (CFLs) and 1,000% more efficient than an incandescents. They have a very long life, with about 50,000 hours of use at 70% of their original power. This works out to eight hours a day for 13 years at 70% power. A typical 60-watt incandescent bulb may last about 1,000 hours.

LED lighting contains no mercury or other toxins. The bulbs emit no ultra violet (UV) light, so they don't attract bugs. The small bulbs don't generate much heat, so they are cool to the touch. They don't generate radio frequency waves, so they don't interfere with radios or television broadcasts. LEDs also are resistant to vibrations and shocks.

There are disadvantages to this type lighting, too. LEDs are more expensive than traditional bulbs. They are heat sensitive, so if they are not used with a steady and consistent current, they can stop working or fade quicker. These lights are also usually best used in directional lighting rather than room lighting, although some changes in design may improve this.

Quite small, LEDs are often used in clocks and watches and as indicator lights in cars. They have fast switching, so they are good in remote controls and lights that are turned on and off frequently. Their directional nature means that they are best used under kitchen counters, in stairways and hallways, or as reading lamps, landscape lighting, and night lights.LED lighting comes in many forms, including screw-in light bulbs, flashlights, strips or clusters. They are as simple to install as other types of lighting and can be found where consumers buy other bulbs and lights.

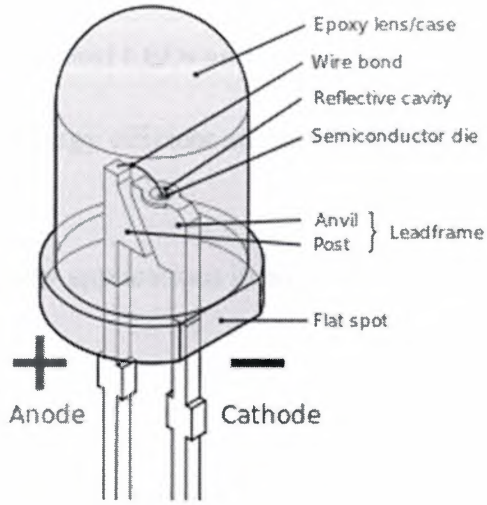

Figure 2.3.5 LED lamp

2.3.6 OLED lamp

The Organic LED is made of a layer of organic electroluminescent material with p/n junction sandwiched between to electrodes. At least one of the electrodes is transparent so the photons can escape. Similar to an EL lamp, current is passed through a semiconductor (like the phosphor in an EL lamp), however the difference is that an OLED uses a p/n junction were there is a recombination of p and n carriers. EL (TDFEL, TFEL, powder EL) technology only uses a material excited by current to make light.

The semiconductor in an OLED is organic which means it contains carbon. The OLED uses one of two kinds of compounds: polymers or 'small molecule'. Read more about how it works below.

Uses:

Lamps - short distance indoor lamps (produces a diffused light)

Displays - small: phones and media devices and large: televisions, computer monitors

Advantages:

-The units are lighter than traditional LEDs and can be made thinner as well

-OLEDs can provide a more energy efficient alternative to LCD computer and television monitors

-Can be used in a myriad of new applications in which lighting technology has never been used before

Disadvantages:

-The cost of OLEDs is still high and each unit produces less lumens than a normal LED

-The technology is still under development so the life of the OLED is being researched as new materials are used and tested each year. Until more research is done we will not know how these lamps with new materials compare with established technology.

2.3.7 Neon Lamp

A neon lamp (also neon glow lamp) is a miniature gas discharge lamp. The lamp typically consists of a small glass capsule that contains a mixture of neon and other gases at a low pressure and two electrodes (an anode and a cathode). When sufficient voltage and an appropriate current is applied between the electrodes, the lamp produces an orange glow discharge. The glowing portion in the lamp is a thin region near the cathode; the larger and much longer neon signs are also glow discharges, but they use the positive column which is not present in the ordinary neon lamp. Neon glow lamps are widely used as indicator lamps in the displays of electronic instruments and appliances.

The Neon lamp is a low pressure gas discharge lamp. It is a cold cathode fluorescent lamp (CCFL). The term "Neon Lamp" is used to describe a CCFL with a tube diameter less than 15 millimeters. Due to the great popularity and ubiquity of the neon lamp we consider it one of the 12 main types of electric lamps in this History of the Electric Lamp.

Advantages

-Good lumen per watt performance.

-Neon performs more reliably in cold weather than hot cathode fluorescent lights.

-More reliable than LEDs for airport runway landing lights.

Disadvantages

-Shape of tube is a limitation

-Argon is not reliable in cold temperatures

-Diffused light (not good for any focused beam applications)

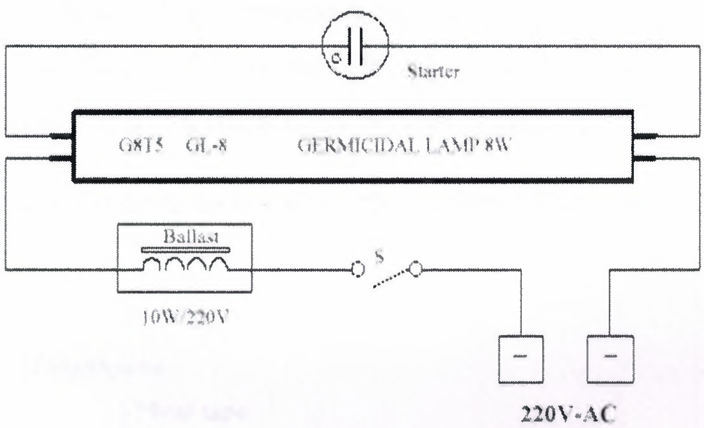

Figure 2.3.7 Neon Lamp wiring schematic.

2.4 CABLES

Electrical cable is an assembly consisting of one or more conductors with their own insulations and optional screens, individual covering(s), assembly protection and protective covering(s). Electrical cables may be made more 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. Copper wires in a cable may be bare, or they may be plated with a thin layer of another metal, most often tin but sometimes gold, silver or some other material. Tin, gold, and silver are much less prone to oxidation than copper, which may lengthen wire life, and makes soldering easier. Tinning is also used to provide lubrication between strands. Tinning was used to help removal of rubber insulation. Tight lays during stranding makes the cable extensible (CBA – as in telephone handset cords).

Cables can be securely fastened and organized, such as by using trunking, cable trays, 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.

At high frequencies, current tends to run along the surface of the conductor. This is known as the skin effect.

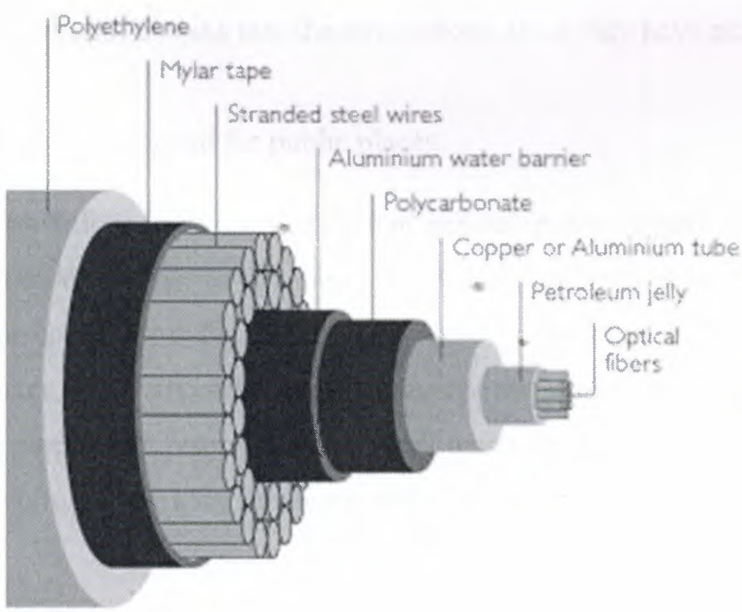

Figure 2.4 Submarine Cables

POWER CABLES :Top Cable's Powerflex Power Cables are known for their great flexibility. Given its ease of installation, they are a favourite for installers.

ELECTRIC PANEL WIRING:Topflex cables, with extraordinary flexibility, make installation easy. These cables are used in home cabling, equipment, cabinets and lighting.
LSZH SAFETY CABLES:The outer sheath of the Toxfree cables by Top Cable, is fire-proof polyolefin, halogen-free and low smoke and corrosive gases emission in case of fire. For this reason, installation of these types of cables is highly recommended in public places such as: hospitals, schools, museums, airports, bus stations, shops in general, etc., as well as in computer centres, offices, production plants, wiring cabinets, laboratories, etc.Top Cable manufactures LSZH safety electric cables in compliance with the highest safety standards. Low Smoke Halogen-free cables are essential in newly constructed buildings and public places. These cables are advantageous because of their fire-resistant qualities and an excellent ability to not propagate the fire. They are classified as safety cables.

The main characteristics of these cables are:

1) They do not propagate fires.
2) Low emission of toxic gases and halogens.
3) They emanate non-opaque smoke.
4) They emit less toxic gases.
5) They do not emit dioxins into the atmosphere, since they have no halogenated material.
6) Specially recommended for public places.

Cables classified as Safety (AS) are installed in general power supply lines which link the general protection case with the power meter, individual circuits that supply electricity to an installation, indoor connections for power meters and installations in public places, such as entertainment venues, hospitals, office buildings, schools, shopping centres, etc.High safety cables (AS+) are specifically reserved for services which are essential in the event of a fire, such as safety circuits, car park or garage ventilation circuits or smoke extraction systems in kitchens.

CONTROL CABLES: The range of Flextel cables belongs to the family of Top Cable's control cables, which we can find in supply systems, public lighting installations, machine connections, lighting and the entertainment industry, and in industrial installations in general.

ARMOURED CABLES: Due to its armour of aluminium or steel, armoured cables are ideal for installations at a risk of mechanical stress.We can find armoured cables from the Powerhard range in installations for the petrochemical industry, service stations, warehouses with flammable products, agricultural facilities, mining and street lighting.

INDOOR CABLES: The flexible indoor cables, in their halogen-free version, are suitable for high safety installations in public places.Halogen-free cables such as Toxfree are highly recommended in public places such as airports, hospitals, museums, schools, shops, offices, car parks, etc.

FIREPROOF CABLES: During a prolonged fire, the Toxfree Plus ZH fire-resistant cables continue transmitting electricity. By doing so, they ensure the supply of electricity to emergency equipment, such as emergency exit lights, smoke exhausts, water pumps or acoustic alarms.The Toxfree Plus 331 ZH SZ1-K (AS+) / RZ1-K (AS+) fire-resistant cable is specially designed to be able to transmit electricity in extreme conditions such as those that occur during a prolonged fire, ensuring supply to emergency equipment, such as lighting signals, smoke exhausts, acoustic alarms, water pumps, etc.

In case of fire, this electric cable does not emit toxic substances or corrosive gases, thereby protecting public health and avoiding any possible damage to electronic equipment. For this reason, its use is recommended in public places such as: hospitals, schools, museums, airports, bus stations, shops in general, tunnels, metros, etc., as well as in computer centres, offices, production plants, laboratories, etc.

RUBBER INSULATED POWER CABLES: Xtrem rubber insulated cables are ideal for power transmission both in a fixed installation or in mobile service. These cables are designed to supply power to low voltage appliances including electric motors and submersible pumps in deep water installations as well as many other types of electrical equipment.

SPECIAL CABLES: There is a large variety of special cables and standards for different cables worldwide. Top Cable manufactures cables in accordance with many of these regulations to serve the global markets and for a wide variety of applications.

2.5 Switch

An electrical switch is any device used to interrupt the flow of electrons in a circuit. Switches are essentially binary devices: they are either completely on ("closed") or completely off ("open"). There are many different types of switches, and we will explore some of these types in this chapter.

Though it may seem strange to cover this elementary electrical topic at such a late stage in this book series, I do so because the chapters that follow explore an older realm of digital technology based on mechanical switch contacts rather than solid-state gate circuits, and a thorough understanding of switch types is necessary for the undertaking. Learning the function of switch-based circuits at the same time that you learn about solid-state logic gates makes both topics easier to grasp, and sets the stage for an enhanced learning experience in Boolean algebra, the mathematics behind digital logic circuits.

The simplest type of switch is one where two electrical conductors are brought in contact with each other by the motion of an actuating mechanism. Other switches are more complex, containing electronic circuits able to turn on or off depending on some physical stimulus (such as light or magnetic field) sensed. In any case, the final output of any switch will be (at least) a pair of wire-connection terminals that will either be connected together by the switch's internal contact mechanism ("closed"), or not connected together ("open").

2.5.1 SWITCH TYPES

AIR SWITCH: An air switch is a switch in which the interruption of the circuit occurs in air. Air is used as the insulation medium between the open contacts (air break switch).

CENTER BREAK SWITCH:A center break switch is a switch with two rotating insulators, located at each end of the base. Rotation of the insulators cause the blade and contact to engage at a point approximately midway between the insulators.

DISCONNECTING SWITCH:A disconnecting switch is an air switch used for changing connections in a circuit or system, or for isolating purposes. It is intended to be operated only after the circuit has been opened by some other means. It has no interrupting rating.

DOUBLE BREAK SWITCH:A double break switch is a switch which opens the connected circuit at two points.

DOUBLE THROW SWITCH:A double throw switch is a switch by means of which a change in circuit connections can be obtained by closing the switch blade into either of two sets of contacts.

FULL LOAD INTERRUPTERS SWITCH:Is an interrupter switch having a current interrupting rating, under specific circuit conditions, equal to the continuous current rating of the switch at rated voltage.

FUSED DISCONNECTING SWITCH:A fused disconnecting switch is a disconnecting switch in which a fuse unit forms a part of the blade.

GROUNDING SWITCH (Ground Switch):A grounding switch is a form of an air switch by means of which a circuit or a piece of apparatus may be connected to ground.

HIGH SPEED GROUNDING SWITCH:Is a grounding switch which incorporates a stored energy mechanism capable of providing a high contact closing speed, at its rated current, independent of the operator. The switch is either opened manually or by a power operator.

HORN GAP SWITCH:A horn gap is a form of an air switch which is provided with arcing horns.

INTERRUPTER SWITCH:An interrupter switch is a combination of an air disconnect switch and a circuit interrupter, which has a current interrupting rating, under specific circuit conditions, equal to or less than the continuous rating of the switch at rated voltage.

ISOLATING SWITCH:An isolating switch is a switch intended for isolating an electric circuit from the source of power. It has no interrupting rating and is intended to be operated only after the circuit has been opened by some other means.

LIMITED CURRENT INTERRUPTER SWITCH:Is an interrupter switch limited to certain types of application, where the types and magnitude of certain interruptions, at rated voltage, is less than the continuous current rating of the switch such as small load currents, magnetizing currents, or capacitor currents.

MOUNTING POSITION OF AN AIR SWITCH:The mounting position of an air switch is determined by and corresponds to the position of the base of the switch.

OIL SWITCH:An oil switch is a switch in which the interruption of the circuit occurs in oil. Oil is used as the insulation medium between the open contacts.

ROTATING INSULATOR SWITCH:A rotating insulator switch is a switch in which the opening and closing travel of the blade is accomplished by the rotation of one or more of the insulators supporting the conducting parts of the switch.

SECTIONALIZING SWITCH:A sectionalizing switch is a switch used for connecting or disconnecting adjacent sections of conductors or feeders.

SELECTOR SWITCH:A selector switch is a form of air switch arranged so that a conductor may be connected to any one of several other conductors.

SIDE BREAK SWITCH:A side break switch is a switch in which the travel of the blade is in a plane parallel to the base of the switch.

SINGLE BREAK SWITCH:A single break switch is a switch which opens the connected circuit at one point only.

SINGLE THROW SWITCH:A single throw switch is a switch by means of which the circuit can be opened or closed by moving the switch blade into or out of one set of contacts only.

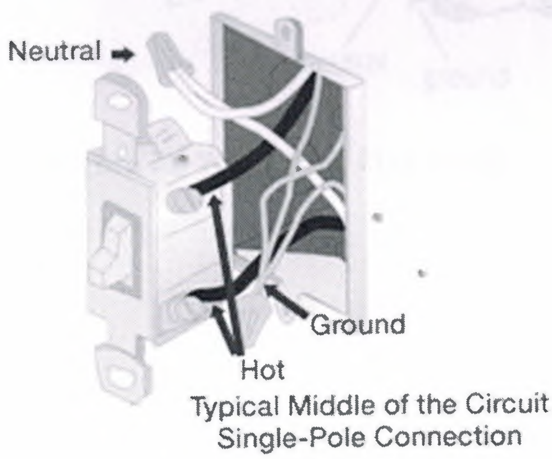

Figure 2.5 Switch

2.6 Power Socket

An electrical outlet is an opening or series of openings connected to a wired power source meant to power electrical equipment and components. It is one of the most commonly used items in a home or building and can be found nearly universally, although many countries have different standards or voltages. As a result, not all outlets, or the components they are intended for, are compatible with each other.

Most household electronic components get their power from a cord that is plugged into the outlet. The plug of the component transfers power from the electrical outlet to the device requiring it. Another wire then takes the electricity back to its original location. For simplification, in a home environment, this is the electrical panel. Due to this round-trip routing, it is often called an electrical circuit.

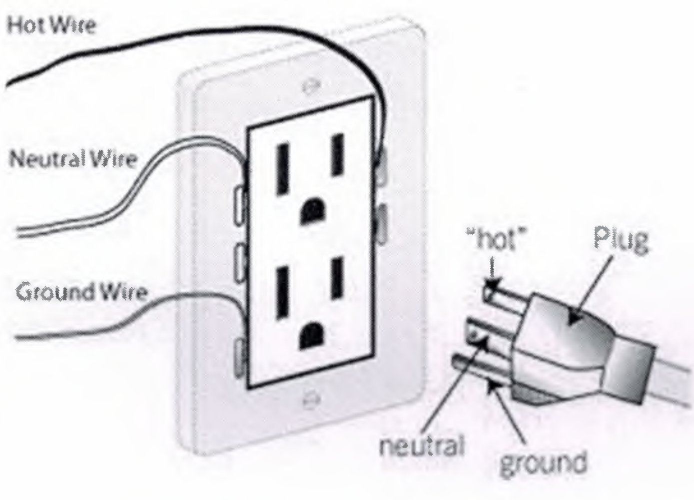

Figure 2.6 Wire a Plug Plug Wiring

2.7 Distribution Board

A distribution board (or panelboard) is a component of an electricity supply system which divides an electrical power feed into subsidiary circuits, while providing a protective fuse or circuit breaker for each circuit, in a common enclosure. Normally, a main switch, and in recent boards, one or more Residual-current devices (RCD) or Residual Current Breakers with Overcurrent protection (RCBO), will also be incorporated.

Other names

Distribution boards are also referred to as a:

- breaker panels
- circuit breaker panel
- consumer unit, or CU
- electrical panel
- fuseboard
- electric board
- fusebox
- breaker box
- load centre/center
- panelboard
- power breaker
- service panel
- DB board (South Africa)
- ACDB (alternating current distribution board)
- DCDB (direct current distribution board)

In the UK, domestic and small commercial or public installations usually have single-phase supplies at 230V (nominal standard). The main distribution boards in these installations are called consumer units (CUs), though they may be known as fuse boxes; older consumer units used fuses until the advent of mini-circuit breakers (MCBs).

A consumer unit normally has a single horizontal row of fuses or MCBs, though some older units grouped four fuses in a square arrangement. For two-rate supplies (standard/off-peak), a second CU may be added (stacked). Multiple CUs are also found in larger premises.

Larger commercial, public, and industrial installations generally use three-phase supplies, with distribution boards which have twin vertical rows of breakers. Larger installations will often use subsidiary distribution boards.

In both cases, modern boards handling supplies up to around 100 A (CUs) or 200 A (distribution boards) use circuit breakers and RCDs on DIN rail mountings. The main distribution board in an installation will also normally provide a main switch (known as an incomer) which switches the phase and neutral lines for the whole supply. (n.b., an incomer may be referred to, or sold as, an isolator, but this is problematic, as it will not necessarily be used as an isolator in the strict sense.)

For each phase, power is fed along a busbar. In split-phase panels, separate busbars are fed directly from the incomer, which allows RCDs to be used to protect groups of circuits. Alternatively RCBOs may be used to provide both overcurrent and residual-current protection to single circuits.

Other devices, such as transformers (e.g., for bell circuits) and contactors (relays; e.g., for large motor or heating loads) may also be used.

2.7.1 Types

There are different types of breaker panels to choose from, each of which meets a certain code requirement or application, depending on your area. Check with local authorities to determine which type of panel meets your local compliance requirements.

Main breaker panels have a built-in main breaker which can be used to shut off all power to your residence. A main breaker is a large double-pole circuit breaker that limits the amount of electricity coming in from outside to protect the circuits it feeds. It also identifies your breaker panel's amperage capacity. Main breakers can be installed when the meter and feeder cable are within 10 ft. of the panel. However, consult your local codes to see if your panel will meet this or another requirement for proper installation.

Main lug panels do not have a main breaker. Instead the line wires run to lugs. This type of breaker panel requires a separate disconnect. The main breaker, which would function as the disconnect, may be located at the meter, or if the main lug panel is used as a sub-panel, it may be connected to the breaker at the main panel. In the event of a fire, the separate disconnect at a meter can be helpful to fire authorities, who don't have to enter the building to cut power.

Sub-panels are separate breaker panels that can contain new circuits, allowing you to readjust energy distribution to better handle your typical usage patterns. Also known as service or circuit breaker sub-panels, they can be a good solution when a breaker panel doesn't have enough slots to add new circuits. A sub-panel is also ideal for situations where multiple circuits are needed in a single separate area, like a workshop or greenhouse. Be aware, however, that sub-panels do not increase the amount of available power. If an increase in electricity is needed, contact your local utility company or an electrician for increased service.

Transfer Switches are a type of sub-panel that transfers portable generator power into electrical power through your breaker panel. If you live in an area where storms are common, you may have a permanent back-up power generator that uses an alternative power source, like propane or natural gas. The generator can be wired directly to the household breaker panel, providing a seamless switch from utility service to back-up power when the electricity goes out. Some generators come with a transfer switch that carries the same rating as the home's main breaker panel.

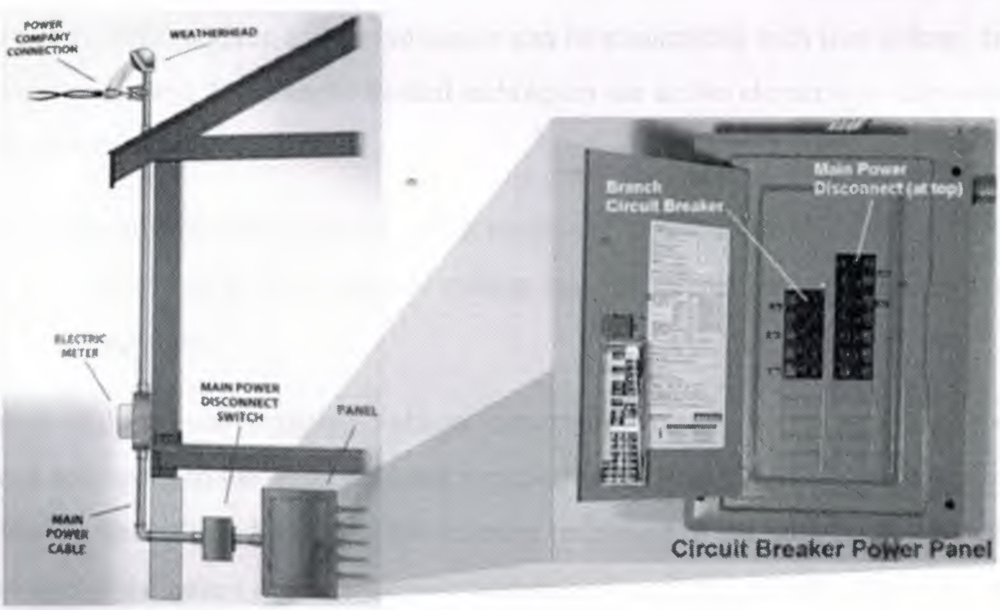

Figure 2.7 Distribution board

3. VOLTAGE DROP

Voltage drop describes how the supplied energy of a voltage source is reduced as electric current moves through the passive elements (elements that do not supply voltage) of an electrical circuit. Voltage drops across internal resistances of the source, across conductors, across contacts, and across connectors are undesired; supplied energy is lost (dissipated). Voltage drops across loads and across other active circuit elements are desired; supplied energy performs useful work.

For example, an electric space heater may have a resistance of ten ohms, and the wires which supply it may have a resistance of 0.2 ohms, about 2% of the total circuit resistance. This means that approximately 2% of the supplied voltage is lost in the wire itself. Excessive voltage drop may result in unsatisfactory operation of, and damage to, electrical and electronic equipment.

National and local electrical codes may set guidelines for the maximum voltage drop allowed in electrical wiring, to ensure efficiency of distribution and proper operation of electrical equipment. The maximum permitted voltage drop varies from one country to another. In electronic design and power transmission, various techniques are employed to compensate for the effect of voltage drop on long circuits or where voltage levels must be accurately maintained. The simplest way to reduce voltage drop is to increase the diameter of the conductor between the source and the load, which lowers the overall resistance. In power distribution systems, a given amount of power can be transmitted with less voltage drop if a higher voltage is used. More sophisticated techniques use active elements to compensate for the undesired voltage drop.

Wires carrying current always have inherent resistance, or impedance, to current flow. Voltage drop is defined as the amount of voltage loss that occurs through all or part of a circuit due to impedance.

A common analogy used to explain voltage, current and voltage drop is a garden hose. Voltage is analogous to the water pressure supplied to the hose. Current is analogous to the water flowing through the hose. And the inherent resistance of the hose is determined by the type and size of the hose - just like the type and size of an electrical wire determines its resistance.

Excessive voltage drop in a circuit can cause lights to flicker or burn dimly, heaters to heat poorly, and motors to run hotter than normal and burn out. This condition causes the load to work harder with less voltage pushing the current.

The National Electrical Code recommends limiting the voltage drop from the breaker box to the farthest outlet for power, heating, or lighting to 3 percent of the circuit voltage. This is done by selecting the right size of wire and is covered in more detail under "Voltage Drop Tables."

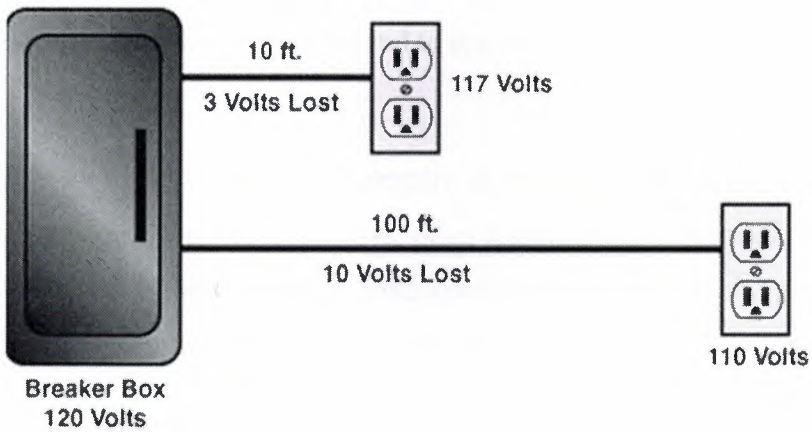

Figure 3. Example of Voltage Drop

If the circuit voltage is 115 volts, then 3 percent of 115 volts is 3.5 volts. This means that voltage lost from the wires in the circuit should not exceed 3.5 volts and the outlet should still have 115 - 3.5 or 111.5 volts to supply. Since most appliances require an extension cord to plug into an outlet, some voltage drop will occur in the extension cord as well. Some motors will not run correctly, and could even burn up, if the voltage at the motor falls too low.

4. Ground

Long-distance electromagnetic telegraph systems from 1820 onwards[citation needed] used two or more wires to carry the signal and return currents. It was then discovered, probably by the German scientist Carl August Steinheil in 1836–1837, that the ground could be used as the return path to complete the circuit, making the return wire unnecessary. However, there were problems with this system, exemplified by the transcontinental telegraph line constructed in 1861 by the Western Union Company between Saint Joseph, Missouri, and Sacramento, California. During dry weather, the ground connection often developed a high resistance, requiring water to be poured on the ground rod to enable the telegraph to work or phones to ring.

Later, when telephony began to replace telegraphy, it was found that the currents in the earth induced by power systems, electrical railways, other telephone and telegraph circuits, and natural sources including lightning caused unacceptable interference to the audio signals, and the two-wire or 'metallic circuit' system was reintroduced around 1883.

In electrical engineering, ground or earth may be the reference point in an electrical circuit from which other voltages are measured, or a common return path for electric current, or a direct physical connection to the Earth.

Electrical circuits may be connected to ground (earth) for several reasons. In mains powered equipment, exposed metal parts are connected to ground to prevent contact with a dangerous voltage if electrical insulation fails. Connections to ground limit the build-up of static electricity when handling flammable products or when repairing electronic devices. In some telegraph and power transmission circuits, the earth itself can be used as one conductor of the circuit, saving the cost of installing a separate return conductor.

For measurement purposes, the Earth serves as a (reasonably) constant potential reference against which other potentials can be measured. An electrical ground system should have an appropriate current-carrying capability in order to serve as an adequate zero-voltage reference level. In electronic circuit theory, a "ground" is usually idealized as an infinite source or sink for charge, which can absorb an unlimited amount of current without changing its potential.

Where a real ground connection has a significant resistance, the approximation of zero potential is no longer valid. Stray voltages or earth potential rise effects will occur, which may create noise in signals or if large enough will produce an electric shock hazard.

The use of the term ground (or earth) is so common in electrical and electronics applications that circuits in portable electronic devices such as cell phones and media players as well as circuits in vehicles such as ships, aircraft, and spacecraft may be spoken of as having a "ground" connection without any actual connection to the Earth. This is usually a large conductor attached to one side of the power supply (such as the "ground plane" on a printed circuit board) which serves as the common return path for current from many different components in the circuit.

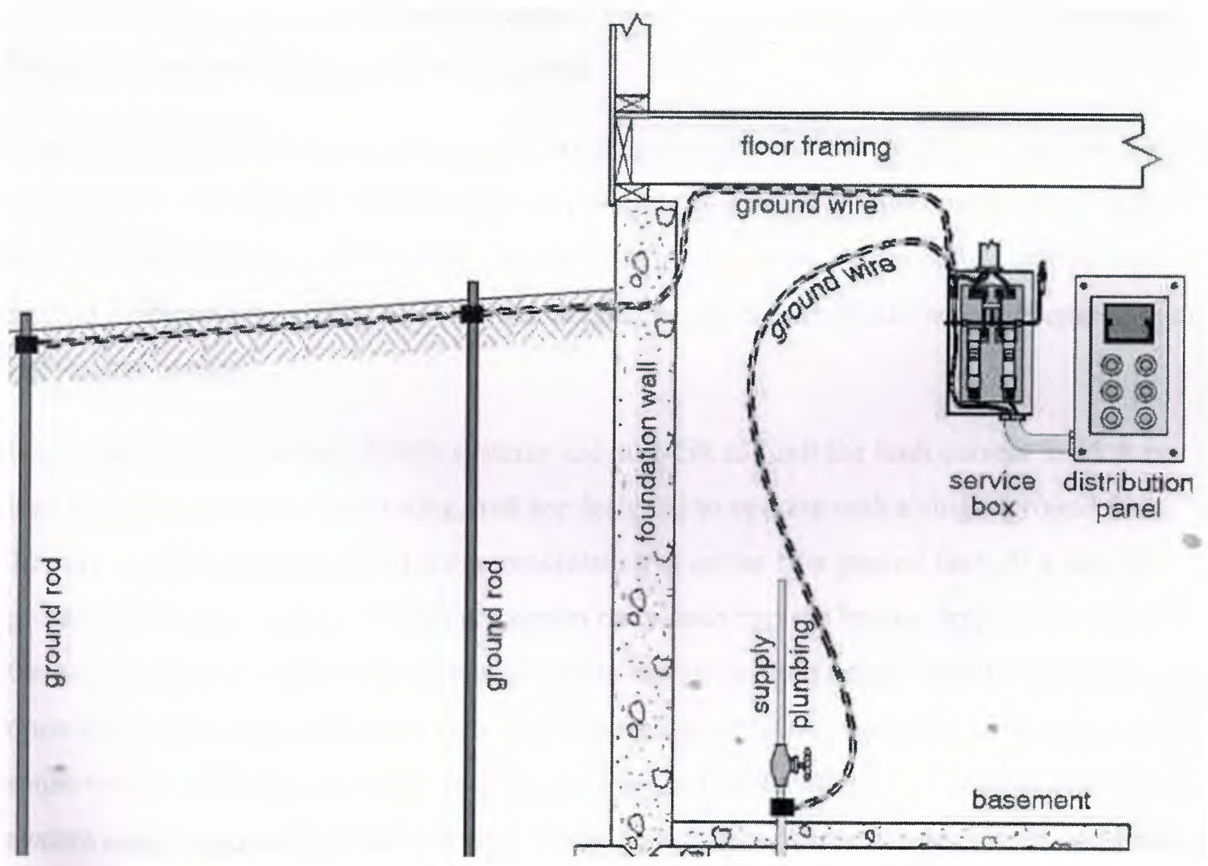

Figure 4. Ground Equipment

4.1 Impedance grounding

Distribution power systems may be solidly grounded, with one circuit conductor directly connected to an earth grounding electrode system. Alternatively, some amount of electrical impedance may be connected between the distribution system and ground, to limit the current that can flow to earth. The impedance may be a resistor, or an inductor (coil). In a high-impedance grounded system, the fault current is limited to a few amperes (exact values depend on the voltage class of the system); a low-impedance grounded system will permit several hundred amperes to flow on a fault. A large solidly-grounded distribution system may have thousands of amperes of ground fault current.

In a polyphase AC system, an artificial neutral grounding system may be used. Although no phase conductor is directly connected to ground, a specially constructed transformer (a "zig zag" transformer) blocks the power frequency current from flowing to earth, but allows any leakage or transient current to flow to ground.

Low-resistance grounding systems use a neutral grounding resistor (NGR) to limit the fault current to 25 A or greater. Low resistance grounding systems will have a time rating (say, 10 seconds) that indicates how long the resistor can carry the fault current before overheating. A ground fault protection relay must trip the breaker to protect the circuit before overheating of the resistor occurs.

High-resistance grounding (HRG) systems use an NGR to limit the fault current to 25 A or less. They have a continuous rating, and are designed to operate with a single-ground fault. This means that the system will not immediately trip on the first ground fault. If a second ground fault occurs, a ground fault protection relay must trip the breaker to protect the circuit. On an HRG system, a sensing resistor is used to continuously monitor system continuity. If an open-circuit is detected (e.g., due to a broken weld on the NGR), the monitoring device will sense voltage through the sensing resistor and trip the breaker. Without a sensing resistor, the system could continue to operate without ground protection (since an open circuit condition would mask the ground fault) and transient overvoltages could occur.

5.COST CALCULATION

Two Apartment Cost Calculation

Type of Material	Number of Item	Price per Item	Total Cost
Distribution board	18	40tl	720 tl
Normal switch	120	4.5 tl	540 tl
Commutator switch	40	7tl	280 tl
Hanger type lamp	160	2.50 tl	400 tl
Normal glob	120	5.5 tl	660 tl
Globin with sensor	2	6.45tl	13tl
Chandelıer lamp	60	25tl	1500 tl
Socket	210	3.45 tl	724.5 tl
automatic stairway lighting switch	18	4tl	72 tl

Total cost :4,909.5 tl

Sixteen Villas Cost Calculation

Type of Material	Number of Item	Price per Item	Total Cost
Distribution board	16	40tl	640 tl
Normal switch	128	4.5 tl	608 tl
Commutator switch	204	7tl	1428 tl
Hanger type lamp	240	2.50 tl	600 tl
Normal glob	176	5.5 tl	968 tl
Globin with sensor	80	6.45tl	516 tl
Chandelıer lamp	**96**	25 tl	2400 tl
Socket	336	3.45 tl	1160 tl
automatic stairway lighting switch	-	4tl	-

Total cost:8,320 tl

- Two Apartment Total Cost = 4,909.5 tl
- Sixteen Villas Total Cost = 8,320 tl

❖ The total cost of the project account =13,229.5 tl

CONCLUSION

The thesis is electrical installation of a Home .This part is the one most important part for engineering. Beginning of this thesis about history for installation. Its about what did happen and when did happen is adout that.

First we started to explain definitions of Electricity and its components.Because in this project the most important thing is Electricity.In this buildings if we don't have an electricity,electric components are not important.All of them works through the electricity.

In the pratical part for drawing installation project by using AutoCAD is prepared.The calculation part is by using excel is prepared.

6.REFERENCES

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