

# NEAR EAST UNIVERSITY

# **Faculty of Engineering**

# Department of Electrical and Electronic Engineering

# **Electrical Illumination and Installation Project**

Graduation Project EE- 400

Student:

# Ahmet Raşit Dolanay (20091240)

Supervisor: Assoc. Professor Özgür C. Özerdem

# TABLE OF CONTENTS



AKNOWLEDGEMENT	
ABSTRACT	ii
INTRODUCTION	iii
1.TYPES OF CIRCUIT	1
1.2. WHAT IS THE RING CIRCUIT	1
1.2.1.Description	1
1.2.2.History and usage	2
1.3.CONVERTING A RADIAL CIRCUIT	3
1.3.1.Radial Circuit and Wiring	3
1.3.2. Meaning of Converting a Radial Circuit	5
1.4.SWITCH OFF ELECTRICITY AT THE MAINS	6
1.5.Older Consumer Units-Fusebox	7
1.6. Never Consumer Units	8
1.7.Finally	8
2. LIGHT SWITCH	9
2.1.History of culture Light switch	9
2.2. What is the Meaning of Light Switch	10
2.2.1.Three-way and four-way	12
2.3.Design of Light Switch	13
2.4.Light Switch of Internal Operation	14
2.5.Types of Light Switch	16
2.5.1.Push Button	16
2.5.2.Toggle	17
2.5.3.Rocker Switches	18
2.5.4.Mercury Switches	18
2.5.5.Electronic Switches	18

3.	ELECTRICAL SAFETY
	3.1.Safety Description
	3.1.1. Perspectives and Responsibilities

3.1.2Engineer's Perspective	21
3.1.3.Contractor's Perspective	21
3.1.4. Maintenance Perspective	22
3.1.5.Manufacturer's Perspective	22
3.2.Modes of Electrical Safety	23
3.2.1.Preventative Mode	24
3.2.2.Real-Time Mode	24
3.2.3.Reactive Mode	25
3.3.Electrical Safety Resources	26
3.4. Application of Safety	26

4. CIRCUIT BREAKER	28
4.1.The meaning of Circuit Breaker	28
4.1.2.Operation MCB	29
4.1.3.Arc Interruption MCB	30
4.1.4.Short Circuit Current	30

4.2. Types of Circuit Breaker	31
4.2.1.Magnetic Circuit Breaker	32
4.2.2. Thermomagnetic Circuit Breaker	32
4.3.Rated Current	32
4.4.Common Trip Breakers	33
4.5. What is difference between an isolator and MCB in an electric circuit?	34
4.6. What is acb/mccb? its function?	35
5. APPENDIX ILLUMINATION CALCULATIONS	36
6.CONCLUSION	61
7.REFERENCES	62

#### ACKNOWLEDGEMENTS

Firstly, I would like to thank to my supervisor Assoc. Prof. Dr. Özgür C. ÖZERDEM for his great advise and recomendation for finishing my Project also, teaching and guiding me in others lectures.

Secondly, I are greatly indepted to my family for their endless support from my staring day in my educational life until today. I will never forget the things that my parents did for me during my educational life.

Finally, I would like thank to my teachers in Near East University, including faculty of engineering. Specially to our **Dean Prof. Dr. Ali Ünal ŞORMAN.** 

i

#### ABSTRACT

The subject of my Project is the illumination and installation. Illumination is in general consists of generation, distribution, economy and measurement of light. The benefits of good illumination are good sight, helping to keep eyes healthy, less accidents, increase productivity, increase economic potential, increase security, increase convertibility.

The main objective of this thesis is to make illumination and installation calculations of a building according to architectural plan that I have. While doing these calculations I tried to use the best methods in order to get the true results. My aim was to make the most suitable design according to these calculations. Efficiency and cost were very important.

#### INTRODUCTION

My Project is about illumination engineering in buildings, illumination and installation calculation.

The first chapter is about circuit types, usage and history. And also contains the meaning of circuit. What types of circuit Ring circuit means use history or Radial and Converting circuit against. After different Ring circuit or Radial and Radial Converting circuit after Ring or Converting circuit afterwards switch of electricity of the times means and older consumers units fusebox however about chapter never consumer units finally this chapter Replace the cover of the fuse box. Switch the power on and test sockets on the old and new part of your new ring circuit.

The second chapter I have researched light switch and History of culture Light switch

1

After chapter means of light switch or connecting of switch afterwards what is the design of light switch and the inside of light switch however this chapter which kind of light switch means of kind toggle, rocket switch, mercury switch, electronic switch after configuration usages today industry in detail.

Third chapter I about of electrical safety and means this chapter safety description after kind of the electrical safety Engineer Contractor Maintenance Manufacturer\_this chapter however modes of electric safety or this section part real time mode or reactive mode more this safety resources plus application safety briefly aim methods is human healthy.

In last chapter I have mentioned about importance of circuit breakers in todays. I talked this chapter Circuit Breaker of The Means and Operation MCB this factor important factor types of circuit breaker working principle human life. More chapter about Arc Interruption MCB and talking kind of Types of Circuit Breaker after this chapter about rated current or Common Trip Breakers and what is difference between an isolator and MCB in an electric circuit?

#### **1. TYPES OF CIRCUIT**

- RING CIRCUIT
- RADIAL CIRCUIT
- CONVERTING CIRCUIT

#### **1.1. WHAT IS THE 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.

#### **1.1.1 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 mm<sup>2</sup> cable and protected by a 30 A fuse, an older 30 A circuit breaker, or a European harmonised 32 A circuit breaker. mineral-insulated copper-clad cable Cpyro) 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.

#### 1.1.2. History and usage

In general the ring circuit are the associated (BS 1363) plug and socket system were developed in Britain 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 can not 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 2x15Afuses, which worked well enough practice, even if unconventional

Many pre-war (round pin) installations used double pole fusing. When 2x 15A radians 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.

2

#### **1.2. CONVERTING A RADIAL CIRCUIT**

- a) converting a radial circuit to
- b) older consumer units-fusebox
- c) never consumer units
- d) finally

#### **1.2.1. Radial Circuit and Wiring**

A radial circuit is a mains power circuit found in some homes to feed sockets and lighting points. It is simply a length of appropriately rated cable feeding one power point then going on to the next. The circuit terminates with the last point on it. It does not return to the consumer unit or fuse box as does the more popular circuit, the ring main. To see the wiring at the back of the socket please go to the ring main project. Two types of radial circuits are permitted for socket outlets. In neither case is the number of sockets to be supplied specified, so the number will be subject to the constraints of load and diversity. The two standard circuits are 20 A fuse or miniature circuit breaker protection with 2.5 mm<sup>2</sup> live and 1.5mm<sup>2</sup> protective conductors ( or 1.5 mm<sup>2</sup> if m.i. cable ) feeding a floor area of not more than 50 m<sup>2</sup>. If the circuit feeds a kitchen or utility room, it must be remembered that a 3 KW device such as a washing machine or a tumble dryer takes 12.5 A at 240 V and that this leaves little capacity for the rest of the sockets. 32 A cartridge fuse to B888 or miniature circuit breaker feeding through 4 mm<sup>2</sup> live and 2.5 mm<sup>2</sup> protective conductors (or 2.5 mm<sup>2</sup> and 1.5 mm<sup>2</sup> if m.i. Cable) to supply a floor area no greater than 75m<sup>2</sup>.



Fig.1.2.1 Radial Circuit

The descriptions below apply only to a circuit for power sockets. Lighting circuits are dealt with in a separate project. There is no limit to the number of sockets used on a radial circuit providing the circuit is contained within an area not exceeding 50 square m, and, just like a ring main, spurs, or extra sockets, can be added. The number of spurs must not exceed the number of existing sockets. The images below are all rated for use with a radial circuit and can be bought by clicking on them.

#### 1.2.2. Meaning of Converting a Radial Circuit

There are two types of radial circuit; 20amp circuits wired with 2.5mm<sup>2</sup> cable and 30 amp circuits wired with 4mm<sup>2</sup>. The principle of the radial circuit, is that the mains cable leaves the consumer unit and passes through each socket until it reaches and ends at the last socket. Alternatively, on a ring circuit the mains cable leaves the consumer unit passes through every socket and then returns to the consumer unit. The advantage of the ring circuit is that electricity can reach the sockets from two directions and so reduces the load on the cable. For other advantages see Types of electrical circuit. The two diagrams show the difference between the radial and ring circuits. The top diagram shows the existing radial circuit, the bottom diagram shows the original radial circuit converted into a ring circuit. (The new part of the circuit is shown in orange). With radial circuits the cable comes from the consumer unit and travels to each socket, simlar to the ring circuit. However when the circuit reaches the last socket the cable ends, whereas a ring main travels back to the consumer unit.Radial circuits can therefore only serve a smaller area. Using 2.5mm<sup>2</sup> cable combined with a 20amp fuse/MCB an area of 20 square metres (24 square yards) is permissible. For 4mm<sup>2</sup> cable combined with a 32amp MCB or a 30amp cartridge fuse (a re-wirable fuse is not allowed) an area of 50 square metres (60 square yards) is permissible. In a similar way to ring circuits spurs can be added at points along the radial circuit if required. High powered appliances (cookers / showers) must have their own radial circuit. Lighting circuits are basically radial circuits. There are two distinct types of lighting, circuit the loop-in circuit and the older junction box circuit. Most houses combine aspects of both types of circuits. The loop-in circuit has a cable, running from light to light terminating at the last light as in the conventional radial circuits and then single cable run from the lights to the light switches.



Fig.1.2.2. :Radial circuit converted to ring circuit

Ring circuits are wired with 2.5mm cable and always have a 30amp fuse/ 32 amp MCB. If your existing radial circuit is a 30amp circuit with 4mm<sup>2</sup> cable you can simply complete the new part of the circuit using 2.5mm<sup>2</sup> cable returning from the last socket to the consumer unit. If however your existing radial circuit is a 20amp circuit using 2.5mm<sup>2</sup> cable, then you can complete the loop back to the consumer unit with 2.5mm<sup>2</sup> cable but the fuse will have to be upgraded from a 20amp to a 30amp fuse. The usual reason to convert a radial to a ring circuit is because the return stretch of cable can be used to add more sockets to the house. Initially, plan the route of the return cable noting the locations of any extra sockets you require. To locate the position of the last socket on a radial circuit, first switch off the power by the main switch on the consumer unit.

#### **1.3. SWITCH OFF ELECTRICITY AT THE MAINS**

All of the sockets on the radial circuit will have two cables going into them, however the last position on the radial circuit will only have a single cable. Once this has been located the cable for the new part of the ring circuit should be connected to it. Ensuring that the power supply is off, remove the conductors from the last point on the radial circuit. Twist together the conductors from the old cable with the new cable i.e. red to red, black to black and green/yellow to green/yellow, (if the earth wire is bare then it should have a green/yellow sleeve placed over the its bare part). Insert the twisted conductors back in their appropriate screw terminals on the back of the socket i.e. red to Live (L), black to Neutral (N) and green/yellow to Earth (E or "v), and replace the socket. Use the remaining length of new cable to return to the consumer unit. If you desire more sockets, leave a generous loop of cable at the new socket points. These points can be installed at a later time (See Installing a power socket). At this point the power should still be OFF. The cover of the consumer unit should now be removed. DANGER: despite the fact that the electricity is switched off, the cables from the meter are still live, so be very careful. Locate the fuseway/MCB with the single cable going out for the radial circuit you are dealing with.

#### **1.4. Older Consumer Units-Fusebox**

For the older consumer unit with fuses, remove the fuse for the circuit you are working on. This exposes the plastic mounting which holds the fuse. This mounting is held in place with a small screw in its centre, by removing this mounting you can gain access to the screw terminal that hold the radials' circuit cable in place - remove this wire.Once you have access, twist the old wire with the new Jive (red) wire and place back in the screw terminal. Tighten the screws and replace the fuse mounting and fuse.If the fuse is 20amp it will need change it to a 30amp fuse. Now find the existing neutral (black) cable from the existing radial circuit and remove it. Twist it together with the new neutral cable and replace.Tighten the screw terminal back up. Finally find the existing earth cable and repeat the process, twisting the old with the new and then replacing in the screw terminal and tightening.

#### **1.5. Never Consumer Units**

For the consumer unit with MCBs (Miniature Circuit Breakers), the red conductor of the existing radial circuit is held in place by a visible screw terminal on the top of the relevant MCB. Undo the screw terminal and remove the wire. The MCB for the new ring circuit must be rated 30/32amp, if it is not then it must be changed before proceeding. Twist the old red wire with the new live (red) wire and secure it back into the screw terminal. Now remove the existing neutral (black) conductor for the radial circuit yuo are working on. Twist it together with the new neutral cable and replace. Tighten the screw terminal back up. Finally find the earth cable and repeat the process, twisting the old wire with the new and then replacing.

#### 1.6.Finally

Replace the cover of the fuse box. Switch the power on and test sockets on the old and new part of your new ring circuit.

#### **2.LIGHT SWITCH**

#### 2.1. History of culture light switch



#### Fig.2.1 : Light Switch

Two light switches in one box. The switch on the right is a dimmer switch. The switch box is covered by a decorative plate. The first light - switch employing quick-break technology was invented by John Holmes in 1884 in the Shieldfield district of the (Newcastle- Upon – Tyne). Light switches are usually built into the walls of the house. Surface mounting is also fairly common though is seen more in commercial industrial and outbuilding settings than in houses. Because of electrical safety considerations in many countries their design and installation is regulated either by law or by widely accepted industry standards. In practice however in most countries any requirements for permits or certification are widely ignored and replacing a light switch is considered a simple "do-it-yourself" task with the parts being widely available. Because of regulatory issues and the fact that light switches aren't something that people are usually too bothered with the looks of they are usually durable and conservative in design. They frequently remain in service for many decades, often being changed only when a portion of a house is rewired. It is not extremely unusual to see century-old light switches still in functional use.

The dimensions, mechanical designs, and even the general appearance of light switches changes very slowly with time. Manufacturers introduce various new forms and styles, but for the most part decoration and fashion concerns are limited to the faceplates. Even the "modern" dimmer switch with knob is at least four decades old, and even in the newest construction the familiar toggle and rocker switch appearances predominate. The shape and size of the boxes and faceplates as well as what is integrated (for example in the UK it is normal to have the switch built into the plate) varies a lot by country. The direction which represents "on" also varies by country. In the United States it is universal for the "on" position of a toggle switch to be "up", whereas in the UK, Australia, and New Zealand it is "down."

#### 2.2. What is the Meaning of Light Switch

A light switch is a switch, most commonly used to operate electric lights, permanently connected equipment, or electrical outlets. In modern homes most lights are operated using switches set in walls, usually 6-10 inches (15-25 cm) away from a door, to operate overhead ceiling lights. In torches (flashlight) the switch is often near the bulb, but may be in the tail, or even the entire head itself may constitute the switch (rotated to turn the light on and off). Home light switches, being in reality a metal or plastic box with a switch in it, commonly have switch plate covers called wall plates. These are plastic, ceramic or metal, and prevent accidental contact with live terminals of the switch. Wall plates are available in different styles and colours to blend in with the style of a room. To switch from one setting to another. The term toggle implies that there are only two possible settings and that you are switching from the current setting to the other setting. A toggle switch is a switch that has just two positions. For example, light switches that turn a light on or off are toggle switches. On computer keyboards, the Caps Lock key is a toggle switch because pressing it can have two meanings depending on what the current setting is. If Caps Lock is already on, then pressing the Caps Lock key turns it off. If Caps Lock is off, pressing the Caps Lock key turns it on. Toggle switches also exist in software. For example a check box in a dialog box is a toggle switch.

A dimmer switch is a kind of light switch that allows a light to be dimmed or brightened continuously. Conceptually, a variable resistor in series with a lamp would allow adjustment of its brightness, but this would be inefficient and costly owing to power dissipated in the resistance as heat. Historically, and still used for some theatrical lighting, a variable autotransformer can be used to adjust the voltage applied to the lamps, and so, the brightness; but this equipment is too large to fit into a standard wall box.Solid-state thyristor switches allow for control of lighting by blocking part of the alternating current for an adjustable time delay, thereby allowing only part of the current through the dimmer and reducing the power input to the lamp.Nearly all dimmers use phase cutting systems based on triacs, controlled by a rotary or sliding knob or, more recently, a touch-sensitive plate. The components are small and low-cost and easily fit into wall boxes designed for on-off switches.Dimmers are intended only for use with permanently-installed lighting fixtures, and generally work best with incandescent lamps. Certain fluorescent fixtures used for commercial lighting can be dimmed, but these have special wiring requirements. Tungsten-halogen lamps may give unsatisfactory service life if operated on a dimmer since the internal redeposition of filament metal may not work properly at lower filament temperatures; see dimmer for more information. A one way switch has two terminals, its the simplest of switch arrangements. it's either on or off, thats all it does. When it's 'ON' the COM terminal is connected to the L1 terminal (let there be light!). When it's 'OFF' the COM terminal is connected to nothing and (the switch is open) no current flows through the switch. A two way switch has three terminals its a little more complicated (any useful) than it's one way cousin. When it's 'ON' (position 1) the COM terminal is connected to the L1 terminal. But when it's 'OFF' (position 2) the current is diverted from the L1 to the L2 terminal. This is what we use in circuits when we want to be able to switch a single light on and off from two different switches.

#### 2.2.1. Three-way and four-way

Three-way and four-way switches make it possible to control a light from multiple locations, such as the top and bottom of a stairway, or either end of a long hallway. These switches are externally similar to normal, single-pole switches, but have extra connections which allow, in effect, two circuits to be controlled, which can be thought of as the "on" circuit and the "off circuit. Toggling the switch disconnects one circuit and connects the other. Electrically, a three-way switch is a single-pole, double-throw (SPDT) switch:





By connecting two of these switches together back-to-back, it can be arranged that toggling either switch changes the state of the light from off to on, or on to off:





A four way switch has two pairs of terminals which it connects either straight through or crossed over:



Fig.2.1.3

#### 2.3. Design of Light Switch





In the case of light switches, the circuit to be switched is within 10% of 230 volts at 5A 6A or 10A for all European and most African and Asian countries, whereas Japan and most of the Americas use a supply between 100 and 127 volts with maximum circuit currents of up to 15 or 20 amperes so the overall power per circuit is similar. In the US it was formerly considered acceptable to mix outlets and lighting on the same circuit; however, building codes in effect for the past three decade in most areas have required that lighting and receptacles be on separate circuits. In the UK putting normal 13A BS1363 sockets on a lighting circuit is frowned upon (though not explicitly prohibited) but 2A or 5A BS546 outlets are often put on lighting circuits to allow control of free-standing lamps from the room's light switches. In the U.S., this is very common in mobile homes. It is common in American site-built housing for living rooms and bedrooms to have a switched receptacle on the receptacle circuit for the same purpose.

#### 2.4. Light Switch Of Internal Operation



Fig.2.4 :Internal operation of a toggle switch (explanation)

A switch is most vulnerable when the contacts are opening or closing. As the switch is closed, the resistance of the switch changes from nearly infinite to nearly zero. At infinite resistance, no current flows and no power is dissipated. At zero resistance, there is no voltage drop and no power is dissipated. When the switch changes state however, there is a brief instant of partial contact when resistance is neither zero nor infinite and power is dissipated. During that transition the contacts heat up. If the heating is excessive, the contacts can be damaged or even weld themselves closed. Thus the switch is designed to make the transition between effectively infinite resistance and effective zero resistance as swiftly as possible. This is achieved by the initial operation of the switch lever mechanism storing potential energy, usually as stress in a spring. When sufficient energy is stored, the mechanism in the switch "breaks over" driving the contacts through the transition from open to close, or close to open, without further input by the switch operator. In addition, during the transition when the contact is broken there is an additional issue that if an inductive load is being switched, the stored energy in the inductor is dissipated as an arc within the switch, prolonging the transition and

worsening the heating effect on the contacts. Thus switches are commonly rated by the current they are designed to break, as this is the most stringent constraint. The arc that results when the switch operates corrodes the switch contacts, in time leading to erosion of the contact surface and fouling of the contact area by corrosion byproducts. A switch therefore has a finite life, again often being rated at a given number of cycles of disconnection at a specified current. Operation outside its design envelope will shorten the switch life very drastically. To combat contact corrosion a switch is usually designed to have a wipe action such that the contact corrosion is cleaned off the area of the contact that forms the low resistance path when the switch is closed. It's also designed so that the initial point of contact, and thus the majority of the contact corrosion, occurs at a sacrificial part of the contact, rather than the face that is in contact when the switch is fully closed. Depending on the switch rating and price, the contact area of the switch is often a sophisticated construction of brass contact, silver contact button, and plated finish to minimize the amount of contact corrosion and thus extend the life of the switch. Many higher current switch designs rely on the separation arc to assist in dispersing contact corrosion, and that a switch designed for high current/high voltage use may become unreliable if operated at very low currents and low voltages because the contact corrosion builds up excessively without an arc to disperse it. When a pair of contacts is badly designed, or overloaded in relation to its design, if the contacts are visible two kinds of "sparks" may be seen. On closure, a few sparks like those from a flint-and-steel may appear as a tiny bit of metal is heated to incandescence, melted, and thrown off. On opening, a bluish arc may occur with a detectable "electrical" (ozone) smell; afterwards the contacts may be seen to be darkened and pitted. Damaged contacts have higher resistance, rendering them more vulnerable to further damage and causing a vicious circle in which the contacts soon fail completely. To make a switch safe, durable, and reliable, it must be designed so that the contacts are held firmly together under positive force when the switch is closed. It should be designed so that regardless of how the person operating the switch manipulates it, the contacts always close or open quickly. Despite this, a switch should not be held between its two positions (on or off); this is especially true on older mechanisms.

The spring that stores the energy necessary for the snap action of the switch mechanism, in many small switch designs is made of a beryllium copper alloy, that is hardened to form a spring as part of the fabrication of the contact. The same part often also forms the body of the contact itself, and is thus the current path. Abusing the switch mechanism to hold the contacts in a transition state, or severely overloading the switch, will heat and thus anneal the spring, reducing or eliminating the "snap action" of the switch, leading to slower transitions, more energy dissipated in the switch, and progressive failure.

#### 2.5. Types of Light Switch

2.5.1. Push Button



Fig.2.5.1 : A push button light switch.

Prior to the toggle switch a popular design was the push-button switch, composed of a depressed button oriented below or beside a raised button. Pushing the raised button opens or closes the contacts while popping out the previously depressed button so the process can be reversed. Push button switch reproductions are available on the market today for vintage or authentic styling.



#### Fig 2.5.2 : A toggle light switch.

The traditional light-switch mechanism is a toggle mechanism that provides "snap-action" through the use of an "overcenter" geometry. The switch handle does not control the contacts directly, but through an intermediate arrangement of springs and levers. Turning the handle does not initially cause any motion of the contacts, which in fact continue to be positively held open by the force of the spring. Turning the handle gradually stretches the spring. When the mechanism passes over the center point, the spring energy is released and the spring, rather than the handle, drives the contacts rapidly and forcibly to the closed position with an audible "snapping" sound. The snap-action switch is a mechanical example of negative resistance. This mechanism is very safe, reliable, and durable, but produces a loud snap or click. (Many people have at some point in their lives made an attempt to reduce this noise by operating the handle slowly or gingerly. Of course this is to no avail, since the very purpose of the mechanism is to ensure that the electrical portion of the switch always operates rapidly and forcefully — and noisily — regardless of how the handle is manipulated). As of 2004 in the United States, the toggle switch mechanism was almost entirely supplanted by "quiet switch" mechanisms. "Quiet switch" mechanisms still possess a form of snap action, but which is very weak as compared to its predecessor.

#### 2.5.3 Rocker Switches

An alernative North American design is the rocker, more commonly know as "decorator" or the Leviton trade name " Decora ". This design sits flush to the wall and is activated by "rocking" a large paddle, rather than pushing a short handle up and down.Besides mechanicalswitches, a large variety of other devices, such as dimmers, electronic switches, motion sensors, night lights, receptacles, low voltage connectors, and GFCIs are available in decorator style giving a consistent look to an installation.Disadvantages, there are fewer styles of the cover plates available and it's more difficult to see at a distance what position a switch is in.

#### 2.5.4 Mercury Switches

Before the 1970s, mercury switches were popular. They cost more than other designs , but were totally silent in operation. The switch handle simply tipped a glass vial, causing a large drop of mercury to roll from one end to the other. As it rolled to one end, the drop of mercury bridged a pair of contacts to complete the circuit. Many of them also would glow faintly when they were "off to aid people in finding them when the room was dark. The vial was hermetically sealed, but concerns about the release of toxic mercury when the switches were damaged or disposed of led to the abandonment of this design. In the U.S. there has never been any effort to recall or replace existing mercury switches, and millions them remain in use.

#### 2.5.5. Electronic Switches

In principle, it is easy to design silent switches in which the mechanical contacts do not directly control the current, but simply signal a solid-state device such as a thyristor to complete the circuit. Many variations on this theme have been created and marketed."Touch-plate" devices can be operated by touching or merely waving a hand near the switch.Public buildings such as hospitals frequently save energy by using " motion-detector " switches .As of 2006 these remain specialty the items, probably because of the greater cost of ensuring safety in the more-complex electronic designs. Unless carefully designed, electronic devices are subject to catastrophic failure in circumstances such as lightning-induced power surges.

#### **3. ELECTRICAL SAFETY**

As an engineer, contractor, manufacturer, or maintenance personnel, and whether one's business is electrical in nature or not, electrical safety is a concern shared by all in the building industry. Approximately 300 deaths occur each year by accidental electrocutions. Over 800 people die annually due to fires caused by electrical faults. Each year, electrical mishaps account for thousands of people sustaining shock injury or bums, and electrical failures cause over 1.3 billion dollars in property damage.



**Fig 3.1** Courtesy of Tim Matyas)

As building systems become more integrated and the industry further embraces sustainable and environmental concepts into design, the importance of continued building operation is more critical. Besides familiar electrical equipment and systems, newer technologies like renewable energy systems and on-site power generation are increasingly becoming an integral part of many projects. Electrical safety issues related to photovoltaic systems and distributed energy resources, such as fuel cells and microturbines, are evolving and must not be overlooked. Electrical safety is an essential element to any successful building project from conception to day-to-day operation. Understanding the importance of electrical safety, how to recognize the forms that electrical safety can undertake, and providing resources for implementing electrical safety in one's work are all required to institute an electrical safety program. For full understanding, electrical safety is broken down into three distinct topics of discussion: Perspectives and Responsibilities, Modes of Electrical Safety, and Electrical Safety Resources. Each topic is independent but all three rely on the availability and enforcement of the others for full implementation of safety measures. One without the others results in exposure to the hazardous or potentially hazardous effects of electrical energy and its impact on personnel and equipment.

#### **3.1. SAFETY DESCRIPTION**



#### **3.1.1.Perspectives and Responsibilities**

The proper mind frame is the first step to establishing responsibility to enforce standards of electrical safety. So, perspective determines the impact electrical safety has on one's work. The four perspectives are defined by recognized and accepted roles within the building industry:

- Engineer
- Contractor
- Maintenance
- Manufacturer

A perspective does not imply or indicate an individual's role or title within an organization. Rather, the perspective defines a frame of reference; For example, an electrician installing a junction box outdoors inspects the box for defects that may have occurred in during the manufacturing process and verifies that it is intended for outdoor installation.



Fig.3.1.1: Perspective Interrelationships

#### 3.1.2. Engineer's Perspective

The engineer's perspective identifies measures necessary to achieve electrical safety in the engineering design process. Hence, the engineer's perspective evolves into a responsibility ensures electrical safety from conception of a need to the implementation of an idea. General responsibilities include:

- Equipment ratings
- Conductor ampacities
- Selective coordination of over current protective devices
- Adherence to applicable codes
- Supply/demand equality
- General power distribution methods

#### 3.1.3. Contractor's Perspective

The contractor's perspective identifies measures necessary for electrical safety in the installation process. Hence, the contractor's perspective evolves into a responsibility that ensures electrical safety from implementation of an idea to complete realization of that idea. General responsibilities include:

- Proper mounting of equipment
- Adequate tightening or torque of connections
- Use of correct tools
- Minimizing of insulation abrasion
- Onsite coordination with other contractors
- Adherence to applicable codes



Fig 3.1.3: Courtesy of Joe Tedesco

The term contractor is not reserved only for electrical contractor but, instead, includes all trades. For example, the mechanical contractor must responsibly utilize the proper method of installation of the mechanical equipment for interconnection of electrical feeds including elevators, HVAC equipment, and controls.

#### **3.1.4. Maintenance Perspective**

The maintenance perspective identifies measures necessary for electrical safety in the operation of a system. This perspective is one that deciphers the preventative, real-time, and reactive actions available to continued system operation. Therefore the maintenance perspective evolves into a responsibility that ensures electrical safety by implementation of preventative programs and ongoing system monitoring. The General responsibilities include:

- Preventative maintenance
- Monitoring of equipment parameters
- · Use of safety measures when working on equipment
- Following tag out procedures
- Use of correct tools
- Thorough knowledge of systems
- Adherence to applicable codes

#### 3.1.5. Manufacturer's Perspective

The manufacturer's perspective identifies measures necessary for electrical safety in the creation and construction of equipment and devices. Hence, the manufacturer's perspective evolves into a responsibility that ensures electrical safety by implementing the other three perspectives during the respective phases of the manufacturing process.



Fig 3.1.5: Courtesy of Peter L. Jannitto, Jr

- Equipment ratings
- Conductor ampacities
- Selective coordination of overcurrent protective devices
- Adherence to applicable codes
- Supply/demand equality
- General power distribution methods
- Proper mounting of equipment
- Adequate tightening or torque of connections
- Use of correct tools
- Preventative maintenance
- Monitoring of equipment parameters

#### **3.2. Modes of Electrical Safety**

Once perspectives and responsibilities are determined, electrical safety is further defined by mode. There are three major modes:

- Preventative
- Real-Time
- Reactive

Each mode constitutes a different approach to safety and is defined by the work performed. The three modes combined form an all inclusive approach to maintaining electrical safety as an integral part of any process or program involving electricity,



Fig.3.2: Mode Interrelations

#### **3.2.1. Preventative Mode**

The preventative mode is identified by administrative actions utilized to ward off or prevent electrical mishaps prior to work being performed. A list of actions for the preventative mode should include:

- Implementation of preventative maintenance programs
- Requiring tagout/lockout procedures
- Instituting second-checks requirements for de-energizing during troubleshooting
- Resourcing applicable codes during design

The initial step towards developing an electrical safety program for an individual or agency is to generate a list of administrative actions identified as " preventative " with respect to the nature of their work.

#### 3.2.2. Real-Time Mode

The real-time mode is identified by procedural actions to ward off or prevent electrical mishaps while performing work. In many cases, the real-time mode is the implementation of actions identified in preventative mode. A list of actions for the real time mode should include:

Preventative maintenance being performed, Tagout/lockout procedures being completed during system repair, Second-checks while de-energizing equipment...

- Applying code requirements during design
- Correct installation procedure
- Proper tie-offs on equipment supports
- Torque checks

An electrical safety program for an individual or agency should generate a list of procedural actions identified as "real time" with respect to the nature of their work and to coordinate those actions with the preventative mode actions.

#### 3.2.3. Reactive Mode

The reactive mode is identified by procedural and administrative actions utilized to address electrical mishaps that are occurring or have occurred. The reactive mode tends to be the main focus of many established programs and generally gamers the most attention by others outside the building industry because of the determinental effect electrical mishaps can cause. A list of actions for reactive mode should include:

- Fire suppression training
- Electrical shock training (see Fig. 3: Effects of Electric Shock Levels)
- CPR training
- Electrical shock victim identification
- Emergency planning
- Electrical system orientation

# AmpsDescription1-15mAPerception of electrical current.15-100 mAMuscles contract and cannot release, severity determined by current<br/>level.100 mAVentricular fibrillation of the heart occurs.> 2 AmpsBody receives major burns due to "frying" effect.

Assume worst case body resistance of 300 Ohms with varying voltage applied to reach listed currents. Current levels and effects remain approximate due to the factors such as health, age, size, etc... of the victim. An electrical safety program for an individual or company agency should generate a list of procedural and administrative actions identified as "reactive" with respect to the nature of their work and coordinate those actions with the preventative and real-time modes.

#### **3.3. Electrical Safety Resources**

Resources abound that enable one or one's agency to better recognize perspective and responsibility for electrical safety. With so many resources available, an electrical safety program should implement a method of sourcing the information into a manner that is easily accessible. An "Electrical Safety Library" is a start to organizing and making the information easier to access. Equally the important is the ability to access different media types. Today, not only is access to the Internet a necessity but multiple entry points are suggested. A dedicated area on the computer network for the electrical information is an excellent way to manage and identify resources on hand and those becoming available. Within the database, electrical safety resources should be categorized by Perspectives and Modes. Lastly, all the electrical safety resources enforced by local ordinance or codes, or required by one's agency should be noted and made available to all users.

#### 3.4. Application of Safety

Electrical safety has been a concern for all since the time electricity became an essential part of everyone's daily lives. However, for those in the building industry, ownership of electrical safety is a necessity. The building industry and all those immediately affected by it often dictate the rules governing one's actions for the benefit of the enduser. Therefore, electrical safety requires a proactive approach the most often initiated at an organizational level. The perspectives, the modes, and resources presented in this Resource Page should be used to establish the framework necessary for one or one's organization to develop or realign an electrical safety program better tailored to meet

one's needs. It is important to note that the first step to any effective safety program is structure, followed by education and implementation. Relevant Codes and Standards National Electrical Code (NEC) - NFPA 70- The NEC is the accepted standard for protection of persons and property from electrical installations. Familiarization with NFPA 70 is a must for any one whose responsibility is designing, installing, verifying and maintaining safe and compliant electrical systems. Information can found through the NFPA website with a membership or printed and electronic versions of the code can be purchased from NFPA and other suppliers. (National Electrical Installation) Standards-The NEIS gives definition to "neat and workmanlike manner" as required by the National Electrical Code. Each standard is submitted for approval by the American National Standards Institute (ANSI). National Electrical Safety Code (NESO) - The NESC is a product of the Institute of Electrical and Electronics Engineers (IEEE). This code provides information on the installation, the operation, and maintenance of electrical systems. The intent of the publication is the safeguarding of persons performing the work. Information, like the NEC, is available with IEEE membership or by buying a printed or electronic version of the code.National Fire Protection Association (NFPA)-The NFPA is the definitive source for everything related to fire protection. The association has developed numerous standards that have been adopted by federal, state, and local jurisdictions as enforceable standards. The site has plenty of free information but more specific information is restricted to members only. National Institute for Occupational Safety and Health (NIOSH) - NIOSH is similar in mission to OSHA but differs by the singular perspective that NIOSH is the federal agency responsible for the prevention of work related disease and injury, and is part of the Centers for Disease Control and Prevention.Occupational Health and Safety Administration (OSHA)-OSHA is the main governmental source for effective safety practices. The website is a vast, the readily accessible information resource with a thorough search engine.

#### **4. CIRCUIT BREAKER**

#### 4.1. The Meaning of Circuit Breaker

A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. The Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city.



Fig.4.1 : A 2 pole miniature circuit breaker

#### 4.1.1. Operation MCB

All circuit breakers have common features in their operation, although details vary substantially depending on the voltage class, current rating and type of the circuit breaker. The circuit breaker must detect a fault condition; in low-voltage circuit breakers this is usually done within the breaker enclosure. The Circuit breakers for large currents or the high voltages are usually arranged with pilot devices to sense a fault current and to operate the trip opening mechanism. The trip solenoid that releases the latch is usually energized by a separate battery, although some high-voltage the circuit breakers are self-contained with current transformers, protection relays, and an internal control power source. Once a fault is detected, contacts within the circuit breaker must open to interrupt the circuit; some the mechanically stored energy within the breaker is used to separate the contacts, although some of the energy required may be obtained from the fault current itself. The stored energy may be in the form of springs or compressed air. Small circuit breakers may be manually operated; larger units have solenoids to trip the mechanism, and electric motors to restore energy to the springs. The circuit breaker contacts must carry the load current without excessive heating, and We must also withstand the heat of the arc produced when interrupting the circuit. Contacts are made of copper or copper alloys, silver alloys, and other materials. Service life of the contacts is limited by the erosion due to interrupting the arc. The Miniature circuit breakers are usually discarded when the contacts are worn, but power circuit breakers and high-voltage circuit breakers have replaceable contacts. When a current is the interrupted, an arc is generated - this arc must be contained, cooled, and extinguished in a controlled way, so that the gap between the contacts can again withstand the voltage in the circuit. Different circuit breakers use vacuum, air, insulating gas, or oil as the medium in which the arc forms. Different techniques are used to extingish the arc including:

 Lengthening of the arc, Intensive cooling (in jet chambers), Division into partial arcs, Zero point quenching, Connecting capacitors in parallel with contacts in DC circuits,

Finally, once the fault condition has been cleared, the contacts must again be closed to restore power to the interrupted circuit.

#### 4.1.2. Arc Interruption MCB

The Miniature low-voltage circuit breakers use air alone to extinguish the arc. Larger ratings will have the metal plates or non-metallic arc chutes to divide and cool the arc.Magnetic blowout coils deflect the arc into the arc chute.In larger ratings, oil circuit breakers rely upon vaporisation of some of the oil to blast a jet of the oil through the arc. Gas (usually sulfur hexafluoride) circuit breakers sometimes stretch the arc using a magnetic field, and then rely upon the dielectric strength of the sulfur hexafluoride (SF6) to quench the stretched arc.Vacuum circuit breakers have minimal arcing (as there is nothing to ionise other than the contact material), so the arc quenches when it is stretched a very small amount (<2-3 mm). Vacuum circuit breakers are frequently used in modern medium-voltage switchgear to 35,000 volts.Air circuit breakers may use compressed air to blow out the arc, or alternatively, the contacts are rapidly swung into a small sealed chamber, the escaping of the displaced air thus blowing out the arc.Circuit breakers are usually able to terminate all current very quickly: typically the arc is extinguished between 30 ms and 150 ms after the mechanism has been tripped, depending upon age and construction of the device.

#### 4.1.3. Short Circuit Current

Circuit breakers are rated both by the normal current that are expected to carry, and the maximum short-circuit current that they can safely interrupt. Under short-circuit conditions, a current many times greater than normal can flow prospective short circuit current). When electrical contacts open to interrupt a large current, there is a tendency for an arc to form between the opened contacts, which would allow the flow of current to continue. Therefore, circuit breakers must incorporate various features to divide and extinguish the arc. The maximum ( short-circuit current ) that a breaker can interrupt is determined by testing. Application of a breaker in a circuit with a prospective ( SCC ) higher than the breaker's interrupting capacity rating may result in failure of the breaker To safely interrupt a fault. In a worst-case scenario the breaker may successfully interrupt the fault,only to explode when reset,injuring the technician.

#### 4.2. Types of Circuit Breaker

Small circuit breakers are either installed directly in equipment, or are arranged in a breaker panel. The 10 ampere DIN rail mounted thermal-magnetic miniature circuit breaker is the most common style in modern domestic consumer units and commercial electrical distribution boards throughout Europe. The design includes the following components:

- Actuator lever used to manually trip and reset the circuit breaker. Also
  indicates the status of the circuit breaker (On or Off/tripped). Most breakers are
  designed so they can still trip even if the lever is held or locked in the on
  position. This is sometimes referred to as "free trip" or "positive trip" operation.
- 2) Actuator mechanism forces the contacts together or apart.
- Contacts Allow current to flow when touching and break the flow of current when moved apart.
- 4) Terminals
- 5) Bimetallic strip
- 6) Calibration screw allows the manufacturer to precisely adjust the trip current of the device after assembly.
- 7) Solenoid
- 8) Arc divider / extinguisher

#### 4.2.1. Magnetic Circuit Breaker

Magnetic circuit breakers use a solenoid (electromagnet) whose pulling force increases with the current. The circuit breaker contacts are held closed by a latch. As the current in the solenoid increases beyond the rating of the circuit breaker, the solenoid's pull releases the latch which then allows the contacts to open by spring action. Some types of magnetic breakers incorporate a hydraulic time delay feature using a viscous fluid. The core is restrained by a spring until the current exceeds the breaker rating. During an overload, the speed of the solenoid motion is restricted by the fluid. The delay permits brief current surges beyond normal running current for motor starting, energizing equipment, etc. Short circuit currents provide sufficient solenoid force to release the latch regardless of core position thus bypassing the delay feature. Ambient temperature affects the time delay but does not affect the current rating of a magnetic breaker.

#### 4.2.2. Thermomagnetic Circuit Breaker

Thermomagnetic circuit breakers, which are the type found in most distribution boards, incorporate both techniques with the electromagnet responding instantaneously to large surges in current (short circuits) and the bimetallic strip responding to less extreme but longer-term over-current conditions.

#### 4.5.3. Rated Current

Under short-circuit conditions, a current many times greater than normal can flow When electrical contacts open to interrupt a large current, there is a tendency for an arc to form between the opened contacts, which would allow the flow of current to continue. Therefore, circuit breakers must incorporate various features to divide and extinguish the arc. In air-insulated and miniature breakers an arc chute structure consisting (often) of metal plates or ceramic ridges cools the arc, and magnetic blowout coils deflect the arc into the arc chute.

Larger circuit breakers such as those used in electrical power distribution may use vacuum, an inert gas such as sulphur hexafluoride or have contacts immersed in oil to suppress the arc. The maximum short-circuit current that a breaker can interrupt is determined by testing. Application of a breaker in a circuit with a prospective short-circuit current higher than the breaker's interrupting capacity rating may result in failure of the breaker to safely interrupt a fault. In a worst-case scenario the breaker may successfully interrupt the fault, only to explode when reset, injuring the technician.

International Standard IEC 60898-1 and European Standard EN 60898-1 define the rated current  $I_n$  of a circuit breaker for low voltage distribution applications as the current that the breaker is designed to carry continuously (at an ambient air temperature of 30 °C). The commonly-available preferred values for the rated current are 6 A, 10 A, 13 A, 16 A, 20 A, 25 A, 32 A, 40 A, 50 A, 63 A, 80 A and 100 A (Renard series, slightly modified to include current limit of British BS 1363 sockets). The circuit breaker is labeled with the rated current in ampere, but without the unit symbol "A". Instead, the ampere figure is preceded by a letter "B", "C" or "D" that indicates the instantaneous tripping current, that is the minimum value of current that causes the circuit-breaker to trip without intentional time delay (i.e., in less than 100 ms), expressed in terms of.

#### 4.4. Common Trip Breakers

When supplying a branch circuit with more than one live conductor, each live conductor must be protected by a breaker pole. To ensure that all live conductors are interrupted when any pole trips, a "common trip" breaker must be used.

33



Fig.4.4 Three pole common trip breaker for supplying a three-phase

device. This breaker has a 2 A rating

When supplying a branch circuit with more than one live conductor, each live conductor must be protected by a breaker pole. To ensure that all live conductors are interrupted when any pole trips, a "common trip" breaker must be used. These may either contain two or three tripping mechanisms within one case, or for small breakers, may externally tie the poles together via their operating handles. Two pole common trip breakers are common on 120/240 volt systems where 240 volt loads (including major appliances or further distribution boards) span the two live wires. Three pole common trip breakers are typically used to supply three phase power to large motors or further distribution boards.

# 4.5. What is difference between an isolator and MCB in an electric circuit?(Miniature circuit breaker)

Isolator is the term used in power transmission and distribution circuit. The unit isolates two sides. It could be a manual isolator or a switchgear r. The Isolator can not isolate on its own when there is a fault on either side of the circuit. It has to be operated to isolate the two sides connected through it. MCB means Moulded Circuit Breaker also it applies to miniature circuit breaker which are small capacity breakers and these too are moulded. So MCB is a breaker but moulded(sealed). The breaker is the term used to a unit which breaks (opens) the circuit.

it has the characteristic and ability to self operate and isolate(break) the circuit if there is a fault down the line. Circuit breakers are used to connect the LOAD to the power circuit(line). Once the breaker has opened it can not get ON by itself. It is to be actuated again.ISOLATORS are used for medium volt/high volt and above. MCBs are used forlow voltage.

#### 4.6. What is acb/mccb? its function?

#### What is acb/mccb difference in electrically/mechanically?

As stated above an ACB is an "air circuit breaker "MCCB is a "molded case circuit breaker". They both serve the same function, which is to isolate a circuit either because you want the power off or to isolate because there is a fault. They both use trip units which monitor the current flowing through the brk and trip when it gets too high. Difference is a ACB typically has what is called an iron frame, meaning it is pretty much all metal. It comes in both low (600V and down US) and medium voltage (2400V-27KV) and various amperage's. ACB's are designed to be completely tore down to the bare bones and rebuilt. A MCCB has a housing that is made from non conductive material. Available for low voltage applications and comes in amperages from the single poles in the panel in your house to 3 phase and about 4000A. MCCB's are not meant to come apart. You can get'em apart, but they really are not meant for rebuilding. Another term you may hear is ICB which is insulated case breakers. These are fairly new, last 8-10 yrs in the US. They provide the best of both worlds, complete maintainability and a non conductive housing.

#### **5.APPENDIX**

## **ILLUMINATION CALCULATION OF A SCHOOL**

#### **Basement** 1

For gym:

 $AxB = 129.3 m^2 A + B = 23,98 m m = 0,9$  Ø<sub>L</sub> = 3750 lumen E<sub>0</sub> = 300 Lux

$$z = 2$$
  $h_1 = 3$  m  $h_2 = 0$  m

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) => \underline{H} = 3 \underline{m}$$

$$k_{index} = \frac{A x B}{(A+B) x H} = \frac{129,3}{23,98*3} => k_{index} = 1,797$$

$$\eta = y_{2} = y_{1} + \left[\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})\right] = 0,41 + \left[\frac{1,797 - 1,5}{2 - 1,5}(0,45 - 0,41)\right] = 0,486$$

$$\emptyset_{total} = \frac{E_{0} x S}{m x \eta} = \frac{300 x (129,3)}{0.9 x 0,486} = \underline{88749 \text{ flux}}$$

$$N = \frac{\emptyset_{total}}{x x \theta_{L}} = \frac{88749}{2 x 3750} = \underline{11,8} \text{ approximate } = 12$$

$$E = \frac{N x z x \theta_{L} x \eta x m}{S} = \frac{12 * 2 * 3750 * 0,486 * 0,9}{129,3} = \underline{304,2 \text{ lux.}}$$

For depot :

 $AxB = 26.4m^2$  A + B = 10.38 m m = 0.9  $\emptyset_L = 1000$  lumen  $E_0 = 50$  Lux

$$z = 2$$
  $h_1 = 3 m$   $h_2 = 0 m$ 

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow \underline{H} = 3 \underline{m}$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{26.4}{10.38 \times 3} \Longrightarrow k_{index} = 0.848$$

$$\eta = y_{2} = y_{1} + \left[\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})\right] = 0.31 + \left[\frac{0.848 - 0.8}{1 - 0.8}(0.36 - 0.31)\right] = 0.322$$

$$\emptyset_{total} = \frac{E_{0} \times S}{m \times \eta} = \frac{50 \times (26.4)}{0.9 \times 0.322} = 4555 \text{ flux}$$

$$N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{4555}{2 \times 1000} = 2.28 \text{ approximate} = 3$$

$$E = \frac{N \times z \times \emptyset_{L} \times \eta \times m}{S} = \frac{3 \times 2 \times 1000 \times 0.322 \times 0.9}{26.4} = 65.86 \underline{lux}.$$

For xystus: KSS

 $AxB = 615m^2$  A + B = 57 m m = 0.9  $\emptyset_L = 3750$  lumen  $E_0 = 280$  Lux min.

$$\mathbf{z} = 2 \qquad h_1 = 3 \ \mathrm{m} \qquad h_2 = 0 \ \mathrm{m}$$

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow H = 3 \text{ m}$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{615}{57*3} \Longrightarrow k_{index} = 3,596$$

$$n = y_{2} = y_{1} + \left[\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})\right] = 0,59 + \left[\frac{3,596 - 3}{4 - 3}(0,63 - 0,59)\right] = 0,614$$

$$\emptyset_{total} = \frac{E_{0} \times S}{m \times n} = \frac{280 \times (615)}{0,9 \times 0,614} = \frac{311617,81 \text{ flux}}{1617,81 \text{ flux}}$$

$$N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{311617,81}{2 \times 3750} = 41,55 \text{ min illumination 280lux so favorable 44...}$$

$$E = \frac{N \times z \times \emptyset_{L} \times n \times m}{S} = \frac{3*2*3750*0,614*0,9}{615} = 296,5 \text{ lux}$$

For corridor:

 $AxB = 44,8m^2$  A + B = 16,32 m m = 0,9  $\emptyset_L = 1000$  lumen  $E_0 = 50$  Lux min.

$$z = 2$$
  $h_1 = 3 m$   $h_2 = 0 m$ 

 $H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow H = 3 \text{ m}$   $k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{61544,8}{16,32*3} \Longrightarrow k_{index} = 0,915$   $\eta = y_{2} = y_{1} + \left[\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})\right] = 0,31 + \left[\frac{0,915 - 0,8}{1 - 0,8}(0,36 - 0,31)\right] = 0,339$   $\emptyset_{total} = \frac{E_{0} \times S}{m \times \eta} = \frac{50 \times (44,8)}{0,9 \times 0,339} = \frac{7341,9 \text{ flux}}{91}$   $N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{7341,9}{2 \times 1000} = 3,67 \text{ so favorable } 4...$   $E = \frac{N \times z \times \emptyset_{L} \times \eta \times m}{S} = \frac{4*2*1000*0,339*0,9}{44,8} = 54,48 \text{ lux}$ 

For wc 1 and 2:

 $AxB = 35m^2$  A + B = 16,83 m m = 0,9  $Ø_L = 2350$  lumen  $E_0 = 50$  Lux min.

$$z = 2$$
  $h_1 = 3 m$   $h_2 = 0 m$ 

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow H = 3 \text{ m}$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{35}{16,83*3} \Longrightarrow k_{index} = 0,693$$

$$n = y_{2} = y_{1} + [\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})] = 0,24 + [\frac{0,693 - 0,6}{0,8 - 0,6}(0,31 - 0,24)] = 0,273$$

$$\emptyset_{total} = \frac{E_{0} \times S}{m \times n} = \frac{50 \times (35)}{0,9 \times 0,273} = \underline{7122.51 \text{ flux}}$$

$$N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{7122.51}{2 \times 2350} = 1,51 \text{ so favorable } 2...$$

$$E = \frac{N \times z \times \emptyset_{L} \times n \times m}{S} = \frac{2*2*2350*0,273*0,9}{35} = 65,98 \underline{lux}$$

#### Basement 2.

For depot 1,2,3,4,5 and 6

 $AxB = 51,5m^2$  A + B = 14,59 m m = 0,9  $Ø_L = 2350$  lumen  $E_0 = 50$  Lux min.

$$z = 2$$
  $h_1 = 3 m$   $h_2 = 0 m$ 

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow \underline{H} = 3 \underline{m}$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{51.35}{14,59*3} \Longrightarrow k_{index} = 1,177$$

$$\eta = y_{2} = y_{1} + \left[\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})\right] = 0,36 + \left[\frac{1,177 - 1}{1,25 - 1}(0,41 - 0,36)\right] = 0,395$$

$$\emptyset_{total} = \frac{E_{0} \times S}{m \times \eta} = \frac{50 \times (51.5)}{0,9 \times 0,395} = 7243,32 \underline{flux}$$

$$N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{7243,32}{2 \times 2350} = 1,54 \text{ so favorable } 2...$$

$$E = \frac{N \times z \times \emptyset_{L} \times \eta \times m}{S} = \frac{2*2*2350*0,395*0,9}{51,5} = 64,95 \underline{lux}$$

For we 1 and 2:  $AxB = 26,77m^{2} \quad A + B = 10,45 \quad m \quad m = 0,9 \quad \emptyset_{L} = 2350 \text{ lumen } E_{0} = 50 \text{ Lux min.}$   $z = 1 \quad h_{1} = 3 \quad m \quad h_{2} = 0 \text{ m}$   $H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow \underline{H} = 3 \text{ m}$   $k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{26,775}{10,45 \times 3} \Longrightarrow k_{index} = 0,861$   $\eta = y_{2} = y_{1} + \left[\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})\right] = 0,31 + \left[\frac{0,861 - 0,8}{1 - 0,8}(0,36 - 0,31)\right] = 0,404$   $\emptyset_{total} = \frac{E_{0} \times S}{m \times \eta} = \frac{50 \times (26,77)}{0,9 \times 0,404} = \underline{3681,24 \text{ flux}}$   $N = \frac{\emptyset_{total}}{x \times \emptyset_{L}} = \frac{3681,24}{1 \times 2350} = 1,57 \text{ so favorable } 2...$   $E = \frac{N \times z \times \emptyset_{L} \times \eta \times m}{S} = \frac{1 \times 2 \times 2350 \times 0,273 \times 0,9}{26,77} = 63,84 \text{ lux}}$ 

For wc a and b:

 $AxB = 34m^2$  A + B = 14 m m = 0.9  $Ø_L = 2350$  lumen  $E_0 = 50$  Lux min.

$$z = 1$$
  $h_1 = 3 m$   $h_2 = 0 m$ 

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow \underline{H} = 3 \underline{m}$$

$$k_{index} = \frac{A x B}{(A+B) x H} = \frac{34}{14*3} \Longrightarrow k_{index} = 0,81$$

$$\eta = y_{2} = y_{1} + [\frac{x_{2} - x_{1}}{x_{3} - x_{1}} (y_{3} - y_{1})] = 0,31 + [\frac{0,81 - 0,8}{1 - 0,8} (0,36 - 0,31)] = 0,313$$

$$\emptyset_{total} = \frac{E_{0} x S}{m x \eta} = \frac{50 x (34)}{0,9 x 0.313} = \underline{6034,79 \text{ flux}}$$

$$N = \frac{\emptyset_{total}}{z x \theta_{L}} = \frac{6034,79}{1 x 2350} = 2,56 \text{ I think, the best choice so favorable 4...}$$

$$E = \frac{N x z x \theta_{L} x \eta x m}{S} = \frac{1*4*2350*0,313*0.9}{34} = 77,88 \underline{lux}$$

For xystus: KSS

 $AxB = 590m^2$  A + B = 51 m m = 0.9  $\emptyset_L = 3750$  lumen  $E_0 = 300$  Lux min.

$$\mathbf{z} = 2 \qquad h_1 = 3 \ \mathrm{m} \qquad h_2 = 0 \ \mathrm{m}$$

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow H = 3 \text{ m}$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{590}{51*3} \Longrightarrow k_{index} = 3,856$$

$$\eta = y_{2} = y_{1} + [\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})] = 0,59 + [\frac{3,856 - 3}{4 - 3}(0,63 - 0,59)] = 0,624$$

$$\emptyset_{total} = \frac{E_{0} \times S}{m \times \eta} = \frac{300 \times (590)}{0,9 \times 0,624} = \frac{315170,94}{112} \text{ flux}$$

$$N = \frac{\emptyset_{total}}{x \times \emptyset_{L}} = \frac{315170,94}{2 \times 3750} = 42,02 \text{ min illumination 300lux so favorable } 44...$$

$$E = \frac{N \times z \times \emptyset_{L} \times \eta \times m}{S} = \frac{44*2*3750*0,624*0,9}{590} = 314,12 \text{ lux}$$

For library:

 $AxB = 250m^2$  A + B = 31,6 m m = 0,9  $Ø_L = 3750$  lumen  $E_0 = 200$  Lux min.

$$z = 2$$
  $h_1 = 3 m$   $h_2 = 0.8 m$ 

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0,8+0) => H = 2.2 m$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{250}{31,6*2,2} > k_{index} = 3,596$$

$$n = y_{2} = y_{1} + [\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})] = 0,59 + [\frac{3,596 - 3}{4 - 3}(0,63 - 0,59)] = 0,613$$

$$\emptyset_{total} = \frac{E_{0} \times S}{m \times n} = \frac{200 \times (250)}{0,9 \times 0,613} = 90628,97 \text{ flux}$$

$$N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{90628,97}{2 \times 3750} = 12,08 \text{ min illumination 200lux so favorable } 13...$$

$$E = \frac{N \times z \times \emptyset_{L} \times n \times m}{S} = \frac{13*2*3750*0,613*0,9}{250} = 215,16 \text{ lux}$$

For informary (REVIR):

 $AxB = 35,7m^2$  A + B = 12 m m = 0,9  $\emptyset_L = 1000$  lumen  $E_0 = 100$  Lux min.

$$z = 4$$
  $h_1 = 3$  m  $h_2 = 0.8$  m

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0,8+0) \Longrightarrow \underline{H} = 2,2 \text{ m}$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{35,7}{12*2,2} \Rightarrow k_{index} = 1,358$$

$$n = y_{2} = y_{1} + [\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})] = 0,41 + [\frac{1,358 - 1,25}{1,5 - 1,25}(0,45 - 0,41)] = 0,427$$

$$\emptyset_{total} = \frac{E_{o} \times S}{m \times n} = \frac{100 \times (35,7)}{0,9 \times 0,427} = 9289.62 \text{ flux}$$

$$N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{9289.62}{4 \times 1000} = 2,32 \text{ min illumination 100 lux so favorable 3...}$$

$$E = \frac{N \times z \times \emptyset_{L} \times n \times m}{s} = \frac{3*4*1000*0,427*0,9}{35.7} = 129,18 \text{ lux}}$$

For machine room:

 $AxB = 56,82m^2$  A + B = 15,5m m = 0,9  $Ø_L = 1000$  lumen  $E_0 = 150$  Lux min.

$$z = 4$$
  $h_1 = 3$  m  $h_2 = 0$  m

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0+0) \Longrightarrow H = 3 \text{ m}$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{56,82}{15,5*3} \Longrightarrow k_{index} = 1,222$$

$$n = y_{2} = y_{1} + [\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})] = 0,36 + [\frac{1,222 - 1}{1,25 - 1}(0,41 - 0,36)] = 0,404$$

$$\emptyset_{total} = \frac{E_{0} \times S}{m \times n} = \frac{150 \times (56,82)}{0.9 \times 0,404} = \underline{23440,59 \text{ flux}}$$

$$N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{23440,59}{4 \times 1000} = 5,86 \text{ min illumination 150 lux so favorable 6...}$$

$$E = \frac{N \times z \times \emptyset_{L} \times n_{1} \times m_{1}}{S} = \frac{6*4*1000 \times 0.404 \times 0.9}{56,82} = 153.58 \underline{lux}$$

For kitchen:

 $AxB = 148,4m^2$  A + B = 25,125m m = 0,9  $\emptyset_L = 3750$  lumen  $E_0 = 250$  Lux min.

$$z = 2$$
  $h_1 = 3$  m  $h_2 = 0.8$  m

$$H = h_{1} - (h_{2} + h_{3}) = 3 - (0,8+0) \Longrightarrow H = 2.2 \text{ m}$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{148,4}{25,125*2,2} \Longrightarrow k_{index} = 2,685$$

$$\eta = y_{2} = y_{1} + \left[\frac{x_{2} - x_{1}}{x_{3} - x_{1}}(y_{3} - y_{1})\right] = 0,56 + \left[\frac{2,685 - 2,5}{3 - 2,5}(0,59 - 0,56)\right] = 0,571$$

$$\emptyset_{total} = \frac{E_{0} \times S}{m \times \eta} = \frac{250 \times (148,4)}{0,9 \times 0,571} = 72193,03 \text{ flux}$$

$$N = \frac{\emptyset_{total}}{z \times \emptyset_{L}} = \frac{72193,03}{2*3750} = 9,63 \text{ min illumination 200 lux so favorable 10...}$$

$$E = \frac{N \times z \times \emptyset_{L} \times \eta \times m}{S} = \frac{10*2*3750*0,571*0,9}{148.4} = 259.72 \text{ lux}$$

For mess hall (yemekhane):

 $AxB = 453m^2$  A + B = 46m m = 0.9  $\emptyset_L = 3750$  lumen  $E_0 = 100$  Lux min.

$$z = 2$$
  $h_1 = 3$  m  $h_2 = 0.8$  m

$$H = h_1 - (h_2 + h_3) = 3 - (0,8+0) \Longrightarrow H = 2,2 m$$

$$k_{index} = \frac{A \times B}{(A+B) \times H} = \frac{453}{46*2,2} \gg k_{index} = 4,476$$

 $\eta = y_2 = y_1 + \left[\frac{x_2 - x_1}{x_3 - x_1}(y_3 - y_1)\right] = 0,63 + \left[\frac{4,476 - 4}{5 - 4}(0,66 - 0,63)\right] = 0,644$ 

 $\emptyset_{total} = \frac{E_o \, x \, S}{m \, x \, \eta} = \frac{125 \, x \, (453)}{0.9 \, x0.644} = 97696, 69 \, \underline{\text{flux}}$ 

 $N = \frac{\emptyset_{total}}{z \, x \, \emptyset_L} = \frac{97696,69}{2*3750} = 13,02 \text{ min illumination } 125 \text{ lux so favorable } 14...$  $E = \frac{N \, x \, z \, x \, \emptyset_L x \, \eta \, x \, m}{s} = \frac{14*2*3750*0,644*0,9}{453} = \underline{134,341} \text{ ux}$ 

For corridor:

k =	1,422	S =	320	Ç =	75	Η=	3
y1 =	0,41	m =	0,9	Z =	2	Eo =	60
y3 =	0,45						
x1 =	1,25	ØL =	1000	N =	24,4	E =	60
x2 =	1,422						
x3 =	1,5	ØT =	48760				
$\eta =$	0,438						
For big	holl:						
k =	1,328	S =	103	Ç=	25,9	H =	3
					- nó		50
y1 =	0,41	m =	0,9	Z =	2	Eo =	50
y3 =	0,45						
x1 =	1,25	ØL =	1000	N =	6,77	E =	50
x2 =	1,328						
x3 =	1,5	ØT =	13544				
η=	0,422						

For personel mess hall:

<u>k</u> =	1,263	S =	35	Ç =	12,6	Η ==	2,2
y1 =	0,41	m =	0,9	Z =	2	Eo =	150
y3 =	0,45						
x1 =	1,25	ØL =	3750	N =	2	E =	158,9
x2 =	1,263						
x3 =	1,5	ØT =	14156				
η=	0,412						

44

For wc 1 and 2 total:

k =	0,679	S =	17,2	Ç =	8,44	H =	3
y1 =	0,24	m =	0,9	Z =	1	Eo =	50
y3 =	0,31						
x1 =	0,6	ØL =	2350	N =	2	E =	65,82
x2 =	0,679						
x3 =	0,8	ØT =	3570				
$\eta =$	0,268						

For small corridor:

$\mathbf{k} =$	0,611	S =	18,8	Ç =	10,3	H =	3
y1 =	0,24	m =	0,9	z =	2	Eo =	50
y3 =	0,31						
x1 =	0,6	ØL =	1000	N =	3	$\mathbf{E} =$	70,04
x2 =	0,611						
x3 =	0,8	ØT =	4283				
n =	0.244						

For shower:

k =	1,044	S =	47	Ç =	15	H =	3
y1 =	0,36	m =	0,9	z =	1	Eo =	50
y3 =	0,41						
x1 =	1	ØL =	2350	N =	4	E =	66,38
x2 =	1,044						
x3 =	1,25	ØT =	7080				
η=	0,369						
-							
For righ	it store:						
k =	1,374	S =	77,7	Ç =	18,9	H =	3
y1 =	0,41	m =	0,9	z =	2	Eo =	50
y3 =	0,45						
x1 =	1,25	ØL =	2350	N =	4	E =	93,6
$x^2 =$	1 274						
2.3.4	1,374						
x3 =	1,374	ØT =	10042				

For right store:

<b>k</b> =	1,506	S =	82	Ç =	18,2	H =	3
y1 =	0,45	m =	0,9	Z =	2	Eo =	50
y3 =	0,51		,				
x1 =	1,5	ØL =	2350	N =	3	E =	69,75
x2 =	1,506						
x3 =	2	ØT =	10107				
η=	0,451						
For left	down store:						
k =	1,224	S =	57,1	Ç =	15,6	H =	3
y1 =	0,36	m =	0,9	z =	2	Eo =	50
y3 =	0,41						
x1 =	1	ØL =	2350	N =	2	E =	59,98
x2 =	1,224						
x3 =	1,25	ØT =	7837				
η=	0,405						
For stor	re 1 and 2 :						
k =	0,761	S =	35,5	Ç =	15,6	H =	3
y1 =	0,24	m =	0,9	Z =	2	Eo =	50
y3 =	0,31						
x1 =	0,6	ØL =	2350	N =	2	E =	70,62
x2 =	0,761						
x3 =	0,8	ØT =	6655				
η=	0,296						

47

## FIRST FLOOR 1

For left lecture 1,2,3,4,5 and 6:

<u>k</u> =	1,48	S =	43,3	Ç =	13,3	H =	2,2
y1 =	0,41	m =	0,9	z ==	4	Eo =	300
y3 =	0,45						
x1 =	1,25	ØL =	1000	N =	9	E =	334,3
x2 =	1,48						
x3 =	1,5	ØT =	32304				
η=	0,447						
For righ	t lecture 1,2,3,4,5	5 and 6:					
k =	1,48	S =	43,3	Ç =	13,3	H =	2,2
y1 =	0,41	m =	0,9	z=	4	Eo=	300
y3 =	0,45						
x1 =	1,25	ØL =	1000	N =	9	E =	334,3

x3 = 1,5 ØT = 32304

η= 0,447

1,48

x2 =

For left corridor:

k =	0,994	S =	86,2	Ç =	28,9	H =	3
,							
y1 =	0,31	m =	0,9	z =	2	Eo =	50
y3 =	0,36						
x1 =	0,8	ØL =	1000	N =	8	E =	59,89
x2 =	0,994						
x3 =	1	ØT =	13358				
η=	0,359						
For right	corridor:						
k =	0,994	S =	86,2	Ç =	28,9	H =	3
y1 =	0,31	m =	0,9	$_{\rm Z} =$	2	Eo =	50
y3 =	0,36						
x1 =	0,8	ØL =	1000	N =	8	E =	59,89
x2 =	0,994						
x3 =	1	ØT =	13358				
η=	0,359						
For centra	al corridor:						

k =	1,09	S =	291	Ç=	89	H =	3
y1 =	0,36	m =	0,9	z =	2	Eo=	50
y3 =	0,41						
<b>x</b> 1 =	1	ØL =	1000	N =	23	E =	53,78
x2 =	1,09						
x3 =	1.25	ØT =	42769				

$$\eta = 0,378$$

For indoor break area:

k =	1,265	S =	88,4	Ç =	23,3	H =	3
y1 =	0,41	m =	0,9	z =	4	Eo =	150
y3 =	0,45						
<b>x</b> 1 =	1,308	ØL =	1000	N =	10	E =	163,3
x2 =	1,265						
x3 =	1,5	ØT =	36738				
$\eta =$	0,401						
For scene	e:						
k =	0,667	S =	25	Ç =	12,5	H =	3
y1 =	0,24	m =	0,9	z =	2	Eo =	300
y3 =	0,31						
x1 =	0,6	ØL =	3750	N =	5	E =	355,7
x2 =	0,667						
x3 =	0,8	ØT =	31632				
η=	0,263						
For vario	ous scene area de	pending of	n above:				
k =	3.517	S =	470	C =	44.6	H =	3
	- ,			,			
v1 =	0,59	m =	0,9	z =	2	Eo =	75
v3 =	0,63		,				
x1 =	3	ØL =	3750	N =	10	E =	87,7
x2 =	3.517						,
	- ,						

x3 =	4	ØT =	64136
η=	0,611		

For student affairs:

k =	0,861	S =	58	Ç =	30,6	H =	2,2
y1 =	0,31	m =	0,9	z =	4	Eo =	150
y3 =	0,36						
x1 =	0,8	$\emptyset L =$	1000	N =	9	E =	176
x2 =	0,82						
x3 =	1	ØT =	30688				
$\eta =$	0,315						
For dire	ctor's room:						
k =	1,083	S =	23,7	Ç=	9,95	H =	2,2
y1 =	0,36	m =	0,9	z =	4	Eo =	250
y3 =	0,41						
x1 =	1	ØL =	1000	N =	5	E =	286
x2 =	1,083						
x3 =	1,25	ØT =	17481				
η=	0,377						
For meet	ing room:			×			
k =	1,122	S =	25,2	C =	10.2	H =	2.2
				,	,		,
y1 =	0,36	m =	0,9	z =	4	Eo =	150
y3 =	0,41						
x1 =	1	ØL =	1000	N =	3	E =	164,7

$x^2 =$	1,122		
x3 =	1,25	ØT =	10926
η=	0,384		

For secretary room:

0,909 S = 17,3 k = 8,65 Ç = H =2,2 0,31 y1 = 0,9 Eo= m = 4 z =250 y3 = 0,36 x1 = 0,8 ØL = 1000 E = N =280,7 4 0,909 x2 = ØT = x3 = 1 14249 η= 0,337

For left wc 1 and 2:

k =	0,709	S =	20,6	Ç =	9,68	H =	3
y1 =	0,31	m =	0,9	Z =	1	Eo =	50
y3 =	0,36						
x1 =	0,6	ØL =	2350	N =	2	E =	69,25
x2 =	0,709						
x3 =	0,8	ØT =	3393				
$\eta =$	0,337						

For right wc 1 and 2:

0,709 S =20,6  $\mathbf{k} =$ Ç = 9,68 H = 3 y1 = 0,31 m = 0,9 1 z = Eo = 50 y3 = 0,36

x1 =	0,6	ØL =	2350	N =	2	E =	69,25
x2 =	0,709						
x3 =	0,8	ØT =	3393				
η=	0,337						
For left	staff room:						
k =	1,791	S =	67	Ç =	17	H =	2,2
y1 =	0,45	m =	0,9	z =	4	Eo=	200
y3 =	0,51						
<b>x</b> 1 =	1,5	ØL =	1000	N =	9	E =	234,5
x2 =	1,791						
x3 =	2	ØT =	30704				
η=	0,485						
For rigł	nt staff room:						
k =	1,791	S =	67	Ç =	17	Η=	2,2
y1 =	0,45	m =	0,9	z =	4	Eo=	200
y3 =	0,51						
x1 =	1,5	ØL =	1000	N =	9	E =	234,5
x2 =	1,791						
x3 =	2	ØT =	30704				
η=	0,485						
For the	lower right lectu	re room :					
k =	1.722	S =	57.2	C =	15.1	H =	2.2
	,		,	3			-,

 $y_1 = 0,45$  m = 0,9 z = 4  $E_0 = 300$ 

y3 =	0,51						
x1 =	1,5	ØL =	1000	N =	10	E =	300
x2 =	1,722						
x3 =	2	ØT =	40002				
$\eta =$	0,477						

For the lower left lecture room:

k =	1,722	S =	57,2	Ç =	15,1	H =	2,2
y1 =	0,45	m =	0,9	z =	4	Eo =	300
y3 =	0,51						
x1 =	1,5	ØL =	1000	N =	10	E =	300
x2 =	1,722						
x3 =	2	ØT =	40002				
η=	0,477						

For big Office:

k =	1,735	S =	61	Ç =	16	H =	2,2
y1 =	0,45	m =	0,9	z =	4	Eo =	250
y3 =	0,51						
x1 =	1,5	ØL =	1000	N =	9	E =	254
x2 =	1,735						
x3 =	2	ØT =	35434				
η=	0,478						

For enter indoor break area:

K = 1,404 $S = 107,2$ $Q = 24,1$	H = 3
----------------------------------	-------

y1 =	0,41	m =	0,9	z =	4	Eo =	150
y3 =	0,45						
x1 =	1,25	ØL =	1000	N =	10	E =	150,3
x2 =	1,484						9-
x3 =	1,5	ØT =	39931				
η=	0,447						

# FIRST FLOOR 2

For left lecture 1,2,3 and 4:

k =	1,455	S =	43	Ç =	13,4	H =	2,2
y1 =	0,41	m =	0,9	Z ==	4	Eo =	300
y3 =	0,45						
x1 =	1,25	ØL =	1000	N =	9	E =	333.6
x2 =	1,455						
x3 =	1,5	ØT =	32370				
η =	0.443						

For right lecture 1,2,3 and 4:

k =	1,455	S =	43	Ç =	13,4	H =	2,2
y1 =	0,41	m =	0,9	z =	4	Eo =	300
y3 =	0,45						
x1 =	1,25	ØL =	1000	N =	9	E =	333.6
x2 =	1,455						
x3 =	1,5	ØT =	32370				
η=	0,443						

For left lecture 5,6,7 and 8:

23,8 9,95 2,2 1,087 Ç= Η= S = $\mathbf{k} =$ 0,9 0,36 z = 4 Eo = 300 y1 =m = 0,41 y3 =1000 N =6 E =342,5 x1 = 1 ØL = 1,087 x2 = 1,25 21021 x3 = ØT = 0,377 η= For right lecture 5,6,7and 8: 1,087 23,8 Ç= 9,95 H =2,2 S = $\mathbf{k} =$ 0,9 0,36 4 Eo =300 y1 =m = z = y3 = 0,41 x1 =1 ØL = 1000 N = 6 E =342,5 x2 =1,087 ØT = 21021 x3 =1,25 0,377 η=

56

For left and right corridor:

k ==	0,999	S =	86,5	Ç =	28,9	Η=	3
y1 =	0,31	m =	0,9	Z =	2	Eo=	50
y3 =	0,36						
x1 =	0,8	ØL =	1000	N =	7	E =	52,4
x2 =	0,999						
x3 =	1	ØT =	13358				
η=	0,36						

For central corridor:

k =	1,102	S =	295	Ç =	89,2	Η=	3
y1 =	0,36	m =	0,9	z =	2	Eo =	50
y3 =	0,41						
x1 =	1,102	ØL =	1000	N =	26	E =	56,47
x2 =	1,09						
x3 =	1,25	ØT =	46043				
n =	0.356						

For Fen lab. 1 and 2 :

k =	1,749	S =	63	Ç =	16,4	Η=	2,2
y1 =	0,51	m =	0,9	z =	2	Eo =	400
y3 =	0,56						
x1 =	2	ØL =	3750	N =	8	E =	415,6
$x^2 =$	1.749						

x3 =	2,5	ØT =	57744
η=	0,485		

For lower left lecture 1 and 2 :

k =	1,492	S =	43	Ç =	13,1	Η=	2,2
y1 =	0,41	m =	0.9	z =	4	Fo =	300
y3 =	0,45		• • •	L	7	E0 -	500
x1 =	1,25	ØL =	1000	N =	8	E =	300.5
x2 =	1,492						
x3 =	1,5	ØT =	31943				
$\eta =$	0,449						
For cer	ntral Fen lab:						
k =	1,652	S =	55	Ç =	15,1	H =	2,2
y1 =	0,45	m =	0,9	Z =	2	Eo =	400
y3 =	0,51						
x1 =	1,5	ØL =	3750	N =	7	E =	402,3
x2 =	1,652						
x3 =	2	ØT =	52205				
$\eta =$	0,468						
For Dire	ector's room:						
k =	1,209	S =	28,7	Ç =	10,8	Η=	2,2
y1 =	0,36	m =	0,9	Z ==	4	Eo =	300
y3 =	0,41						
x1 =	1	ØL =	1000	N =	6	E =	302,4

x2 =	1,209		
x3 =	1,25	ØT =	23810
η=	0,402		

For lower left(second) Ib room:

k =	1,272	S =	31,42	Ç =	11,2	H =	2,2
y1 =	0,41	m =	0,9	z =	4	Eo =	300
y3 =	0,45						
x1 =	1,25	ØL =	1000	N =	7	E =	331,7
x2 =	1,272						
x3 =	1,5	ØT =	25327				
η=	0,414						

For secretary room:

k =	0,995	S =	24,18	Ç =	11,1	H =	2,2
y1 =	0,31	m =	0,9	$\mathbf{Z} =$	4	Eo =	150
y3 =	0,36						
x1 =	0,8	ØL =	1000	N =	3	E =	160,2
x2 =	0,995						
x3 =	1	ØT =	11233				
η=	0,359						

For indoor break area:

<u>k</u> =	1,386	S =	98,43	Ç =	23,7	H =	3
y1 =	0,41	m =	0,9	z =	4	Eo=	150
y3 =	0,45						

x1 =	1,25	ØL =	1000	N =	10	E =	157,9
x2 =	1,386						
x3 =	1,5	ØT =	37996				
η=	0,432						

For The manager's room:

k =	1,232	S =	29,7	Ç =	11	H =	2,2
y1 =	0,36	m =	0,9	z =	4	Eo =	250
y3 =	0,41						
x1 =	1	ØL =	1000	N =	6	E =	295,6
x2 =	1,232						
x3 =	1,25	ØT =	20300				
η=	0,406						

#### CONCLUSION

My project is about building illumination, distribution and installation. First of all I tried to use the best methods in order to get the true results. Because safety and correct answer are very important in electrical engineering.

The standart illumination level data is obtained from the standards of EMO's table and from my illumination lecture notes. The type and number of armature is selected from the standarts and calculations.

I explained about circuit types and their usages. After next section I explained about switch and their working principles and configuration usages of today.

However I have explained the types of circuit breakers and importance of circuit breakers in human life. I also clarified the principles and operations of circuit breakers.

In my project I did illumination calculations for given building design. I decided what types of lamps, plugs and sockets should be used in each room. I calculated how many lamps should be used in a room. Cable cross sections and illumination levels that I used in My project are from standarts of EMO.

Finally, My aim was to design good quality, economic and safety building.

#### 7. REFERENCES

#### **Electrical Safety**

http://www.wbdg.org/resources/electricalsafety.php

#### **Radial Circuit**

http://www.divdoctor.org.uk/proiects/radialcircuit.htm

#### **Ring Circuit**

http://en.wikipedia.org/wiki/Ring circuit, Converting A

#### **Radial Circuit to Ring Circuit**

http://www.diynot.com/pages/el/elQ 16,php

#### Light Switch

Electric Light Years 1878-1899 - Timeline of North East England History

http://en.wikipedia.org/wiki/Plugs and Socets

http://www.ewh.ieee.org/SoceLs/dallas/cn/Plugs/levine r.htm

AT&T Bell Modulation Laboratories, c. 1984. p.518 et. Se