NEAR EAST UNIVERSITY



Faculty of Engineering

Department of Electrical and Electronic Engineering

ELECTRICAL INSTALLATION OF THE NEU LIBRARY

Graduation Project EE 400

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ABSTRACT

The interior electrical installation of the Near East University's library is going to be designed in this project with a brief description of the basic and safety components of installation along with the illumination calculations.

The aim is to meet the standard installation requirements and take into consideration the power consumptions along with the decorative side of installation.

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INTRODUCTION

Light in general is the energy affecting the eye and electrical installation deals with generating, distributing, and measuring this light keeping in mind the economic considerations.

This project handles the electrical installation of the Near East University's library. The library consists of three floors, each containing three blocks.

Chapter one gives a brief description about cables, their types and ratings.

Chapter two talks about the safety components used in installations such as switches, fuses and circuit breakers, as well as the types of circuits used in electrical installations.

Chapter three deals with the calculations necessary for illumination.

After doing the calculations, the library's interior electrical installation is designed and sketched using AutoCAD.

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CHAPTER 1: CABLES

1.1 Wires

A wire is different than a cable. Cables refer to two or more wires or conductors grouped together in a jacket. Copper or tinned copper is the most common conductor in wiring because it has minimum resistance at reasonable cost.

A Wire is grouped by a gauge number, running from 0000 to No. 40. The smaller the number, the thicker the wire. Larger wires carry more current, forcing too much current through a wire will cause it to overheat and trip a breaker.

Wires are also characterized by letters that correspond to the insulation type and electrical capacity. Grounding wires provide a path of least resistance from the frame or case of an appliance to the ground to guard against electric shocks. Both two- and three-conductor cables can carry grounding wires.

1.2 Cables

A cable refers to a collection of two or more strands of wire or conductors. Basically, cables have a "hot" line to carry the current and a "neutral" line to complete the loop. They often have a third wire as that acts as a grounding wire.

Cables are classified according to the number of wires they contain and their size or gauge. All cables are marked with a series of letters followed by a number, a dash and another number. The letters indicate the type of insulation (cord, wire and insulation). The first number indicates the resistance of the wires in the cable, and the number following the dash indicates the number of individual conductors in the cable. If the designator "G" follows the series it means that the cable is also equipped with a non-current-carrying ground wire.

The most common jackets are NM-B (Non-Metallic Building Indoor), UF-B (Underground Feed) and BX, which is a flexible metallic cable.

BX cable is an armored metallic cable. It consists of two or three insulated wires individually wrapped in spiral layers of paper. The steel casing acts as a ground wire. There is also a bond wire included in the casing that acts as a ground if the casing breaks.

A Romex cable is a flat, beige thermoplastic jacket surrounding two or three wires. Each wire is wrapped in insulation and a spiral paper tape. Type NM means it can be used indoors. Type NMC means it can be used indoors or outdoors. Type UF means it is suitable for use underground outdoors.

1.2.1 Normal Pvc Cables

PVC is a popular and most commonly used polymer for cables production worldwide but especially in Europe. It is mainly dominant in the low voltage and in some specialist applications. Telecommunication is also an important application for PVC. PVC cables have a number of benefits, such as:

- Good electrical and insulation properties over a wide temperature range
- Inherent fire safety
- Excellent durability and long-life expectancy
- Easy processing characteristics to achieve desired specification for endproducts
- Cost-effectiveness
- Re-usability no cross-linking therefore the ability to be reprocessed back into cable applications.
- Compares favorably to alternative materials using LCA methodologies primarily due to lower usage of non-renewable resources
- That is, 43% derived from oil/gas and 57% derived from salt
- Highly resistant to degradation by ultra violet light

However, since PVC cables are made of thermoplastic material, they are affected by the extremes of heat or cold. The material should not be installed where the ambient (surrounding) temperature is above 65°C or the operating temperature of the cable is above 70°C.

Below about 0°C, PVC becomes brittle so that it is inadvisable to use it for the temporary wiring of buildings or in refrigerator cold rooms. In these situations the PVC covering will split and crack when sharply bent. in addition, it can easily be shattered by sharp blows.

1.2.2 Thermostat Cables

Thermostat cables are used in low-voltage control, alarm and communication systems. Most common types are braided, twisted and plastic-jacketed types. All three use solid copper conductors and are twisted and insulated with plastic.

Although thermostat cable is low voltage, it carries an UL-listing for being flameretardant, since it is installed in the wall. Wiring used in security alarm and smoke detection systems must be UL-listed.

Twisted cables, which have no outer braid, are used in doorbells, burglar alarms, intercom telephones and public address systems. Braided cables are covered with cotton braid and are used primarily in thermostat controls and other low-voltage, remote control circuits. Plastic-jacketed cables are also used in similar low-voltage applications.

1.2.3 High- Temperature Cables

Modern building construction and environmental conditions have brought an increasing demand for cable insulation that is able to withstand the effects of temperatures in excess of 70°C.

The term electrometer is often employed for this class of insurants. Here the chemical compounds have to be vulcanized or cured in order to convert them to a suitable, tough or elastic condition. One of the butyl! Rubber is a synthetic rubber- like material and its normal operating temperature may be extended to 85°C. EPR (ethylene propylene rubber) has somewhat similar physical properties and may be installed in temperature as low as -70°C it should not be directly exposed to oil or greases and requires a hover (heat, oil and fire resistant) sheeting.

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Silicone rubber resembles natural rubber and has an even wider range of utilization from 150°C to -75°C. It may be used at temperature up to 200°C for intermittent operations without detraction.

1.3 Cable Ratings

There is an increasing move away from 70oC P.V.C. insulation to materials which are more environmentally friendly, for example 90oC XLPE. The ratings of fuse gear, switches, accessories etc. are generally based upon the equipment being connected to conductors intended to be operated at a temperature not exceeding 70oC in normal service.

In view of the above, it is recommended that the practice of designs based upon conductor temperatures of 70oC be regarded as the norm. In accordance with clause 512-02-01 of the Wiring Regulations, the equipment manufacturer should be consulted to ascertain the reduction of nominal current rating of the equipment if conductor temperatures exceeding 70oC are used.

CHAPTER 2: SAFETY COMPONENTS

2.1 Switches

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



Figure 2.1 A toggle switch in the "on" position.

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

A pair of contacts is said to be 'closed' when there is no space between them, allowing electricity to flow from one to the other. When the contacts are separated by a space, they are said to be 'open', and no electricity can flow.

Switches can be classified according to the arrangement of their contacts. Some contacts are normally open until closed by operation of the switch, while others are normally closed and opened by the switch action. A switch with both types of contact is called a changeover switch.

The terms pole and throw are used to describe switch contacts. A pole is a set of contacts that belong to a single circuit. A throw is one of two or more positions that the switch can adopt. These terms give rise to abbreviations for the types of switch which are used in the electronics industry. In mains wiring names generally involving the word way are used; however, these terms differ between British and American English and the terms two way and three way are used in both with different meanings.

Electronics abbreviation	Expansion of abbreviation	British mains wiring name	American mains wiring name	Description	Symbol	IEC 60617
SPST	Single pole, single throw	One way	Two way	A simple on- off switch: The two terminals are either connected together or not connected to anything. An example is a light switch.		6
SPDT	Single pole, double throw	Two way	Three way	A simple changeover switch: C (Common) is connected to L1 or to L2.		
SPCO	Single pole changeover or Single pole, centre off		Set 1 Set	Equivalent to SPDT. Some suppliers use SPCO for switches with a stable off position in the centre and SPDT for those without.		Ş

 Table 2.1 British and American main wiring names [6]

DPST	Double pole, single throw	Double pole	Double pole	Equivalent to two SPST switches controlled by a single mechanism	0 0	E.
DPDT	Double pole, double throw			Equivalent to two SPDT switches controlled by a single mechanism: A is connected to B and D to E, or A is connected to C and D to F.		Log Log
DPCO	Double pole changeover or Double pole, centre off			Equivalent to DPDT. Some suppliers use DPCO for switches with a stable off position in the centre and DPDT for those without.		7
		Interme diate switch	4-way switch	DPDT switch internally wired for polarity- reversal applications: only four rather than six wires are brought outside the switch housing; with the above, B is connected to F and C to E; hence A is connected to B and D to C. or A is		X

connected to C and D to B.	

Switches with larger numbers of poles or throws can be described by replacing the "S" or "D" with a number or in some cases the letter T (for triple). The terms SPST SPDT and intermediate are used to avoid the ambiguity in the use of the word "way".

2.1.1 Main Switch

The main switch allows you to turn off the electricity supply to the electrical installation. Note that some electrical installations may have more than one main switch. For example, if your house is heated by electric storage heaters, you will probably have a separate main switch and consumer unit arranged to supply them.



Figure 2.2 Main switch

It is important to know where the consumer unit is located and that it is accessible. It is also important that you know where the main switches are in order to turn it (them) off in the event of an emergency.

2.2 Grounding

The term "ground" refers to a connection to the earth, which acts as a reservoir of charge. A ground wire provides a conducting path to the earth which is independent of the normal current-carrying path in an electrical appliance. The ground wire and a fuse or breaker is the standard safety devices used with standard electric circuits.



Figure 2.3 A grounded socket

The appliance will operate normally without the ground wire because it is not a part of the conducting path which supplies electricity to the appliance. In fact, if the ground wire is broken or removed, you will normally not be able to tell the difference. But if high voltage has gotten in contact with the case, there may be a shock hazard. In the absence of the ground wire, shock hazard conditions will often not cause the breaker to trip unless the circuit has a ground fault interrupter in it. Part of the role of the ground wire is to force the breaker to trip by supplying a path to ground if a "hot" wire comes in contact with the metal case of the appliance.

2.3 Fuses

Fuses operate because the fuse element is the 'weak link' in the circuit, so that over current will melt it and break the circuit. The time taken for the fuse link to break the circuit (to 'blow') varies depending on the type of fuse and on the characteristic of the device.

When the current carried is very much greater than the rated value (which is usually associated with a fault rather than with an overload) operation is usually very fast. For small overloads, where the current is not much larger than the rated value, operation may take a very long time.

The diameter of copper wires for use as elements in fuses is show in the following table:

Fuse element rating (A)	Wire diameter (mm)
3	0.15
5	0.20
10	0.35
15	0.50
20	0.60
25	0.75
30	0.85
45	1.25
60	1.53

 Table 2.2 Sizes of tinned copper wire fuse elements [4]

All fuses must be clearly labeled with the fuse rating to make replacement with the wrong fuse as unlikely as possible. It must not be hazardous to make or break a circuit by insertion or removal of a fuse.

2.4 Circuit Breakers

A circuit breaker is an electric device that, like a fuse, interrupts an electric current in a circuit when the current becomes too high. The advantage of a circuit breaker is that it can be reset after it has been tripped; unlike a fuse, which must be replaced after it has been used once. When a current supplies enough energy to operate a trigger device in a breaker a pair of contacts, conducting the current, are separated by preloaded springs or some similar mechanism. Generally, a circuit breaker registers the current either by the current's heating effect or by the magnetism it creates in passing through a small coil. Because it is usual for an electric arc to form between the contacts when a breaker opens, some means must be provided for preventing rapid erosion of the contacts. Normally this is done by opening the contacts fast enough to make the arc of short duration. Circuit breakers are used in complicated power circuits.



Figure 2.4 A Circuit breaker

2.4.1 Circuit Breaker Components

- The four basic components of a circuit breaker are:
- Frame or case made of metal or some type of electrical insulation
- Electrical contacts and operating mechanisms
- Trip unit, containing either a thermal element, a magnetic element or both Arc extinguishing assembly

Those components are seen in the following figure and a description of the first three components is then given.



Figure 2.5 Characteristics of a Circuit Breaker

2.4.1.1 Frame

The rigid circuit breaker frame provides a method by which all the required components can be mounted and kept in place, ensuring the proper operation of the circuit breaker. The circuit breaker frame provides the rigidity and strength required to successfully deal with the interruption process and achieve the desired interrupting ratting. The frame's mechanical strength must be sufficient to withstand the forces created by the square of the current (I2), which could be quite large and potentially destructive. The frame also provides insulation and isolation of the current path, offering personnel protection near the equipment during operation

Historically, there are two types of frames:

- Metal Frame
- Molded Insulating Material



Figure 2.6 Circuit Breaker Frame

2.4.1.2 Contacts and Operating Mechanism

Contacts

Contacts in a circuit breaker provide a method for connecting the circuit with the system. They also provide a method for isolating a part of a circuit from the rest of the system. A contact set contains a fixed and a movable contact. As a circuit breaker opens or closes, the fixed contact maintains its position while the movable contact moves to close (make) or open (break) the circuit. When all is said and done, contacts perform a simple function; they open and close.



Figure 2.7 Contacts and Operating Mechanism

Operating Mechanism

Circuit breakers require some type of operating mechanism to open and close the contacts. This operating mechanism can be mechanical or a combination of mechanical and power. Depending upon the type of circuit breaker being considered, the operating mechanism could be called upon to:

- Open and close the contacts manually
- Open and close the contacts on demand
- Open the contacts automatically

Let's consider a basic Three-Phase circuit breaker. It is designed such that all three sets of contacts open or close simultaneously.

This requires that all the contacts be linked together in some manner. This part of the mechanism might be connected mechanically to a common handle. The handle, when operated, puts the mechanism into motion and opens or closes the circuit breaker by opening or closing the contacts.



Figure 2.8 Three-Phase Contacts

This additional assistance takes the form of springs. Springs play a big role in the precise functioning of circuit breaker mechanisms. Springs are stretched or compressed to provide the energy necessary to assist with the proper opening or closing of the contacts.

2.4.1.3 Trip Units

For a circuit breaker to be effective, it needs to have some intelligence to enable it to perform automatically or respond to a command. Without this capability, a circuit breaker would just be a fancy switch. A trip unit is the circuit breaker's intelligence.



Figure 2.9 Circuit Breaker Trip Units

The trip unit's function is to trip the operating mechanism (open the circuit) in the events of these over current conditions:

- Thermal Overload
- Short Circuit Currents (Fault Current)
- Ground Fault

2.4.2 Circuit Breaker Types:

2.4.2.1 Miniature Circuit Breakers (MCB)

A miniature circuit breaker is a device that switches and/or protects the lowest common distributed voltage in an electrical system. It is designed to protect conductors and insulation from damage due to Overload (or over current) and Short Circuit. Think about the electrical utility and where the electricity is generated. The residential load center is certainly at the end of the distribution system. It is there that the voltages are the lowest of the distributed voltages in the electric utility's system. Miniature circuit breakers are not just for residential applications only. They are used in residential, commercial and industrial applications. In an industrial or commercial application, miniature circuit breakers can be found in load centers, lighting Panel boards and individual mountings.



Figure 2.10 Typical Miniatures Molded Case Circuit Breakers applications

Miniature circuit breakers fall into two categories. These are:

Residential-Residential miniature breakers are only of the Plug-In type. These are designed for residential load centers, commercial units, and light industrial applications. They typically range from 10 to 125 amps, with an interrupting rating of 10 or 22 KAIC.

Industrial-These breakers are designed for three types of mounting applications: plugin, Bolt-On, and Cable-In/Cable-Out.

Industrial miniature breakers are designed to protect small branch circuits in commercial or industrial electrical distribution systems. They are applied in load centers, lighting panel boards or individual mounting applications. They typically range from 6 to 125 amps, with an interrupting ratings as high as 65 KAIC. Some potential customers are original equipment manufacturers (OEMs) involved in industrial control panels and electrical machinery, such as machine tool equipment, material handling and packaging systems. In addition, look for involvement with printing machines, food-processing systems, uninterruptible power supplies (UPS) and HVAC (heating, ventilation and air conditioning). Each miniature breaker is rated to handle a specific load. For example, a circuit breaker protecting a branch used with kitchen appliances has a higher rating than a circuit breaker protecting a branch with an overhead lighting fixture on it.

Categorizing Miniature Circuit Breakers

Specifications for miniature circuit breakers vary widely. As such, there is a miniature circuit breaker to fit virtually any application, standard and local code requirement. In general, miniature circuit breakers are often categorized by the following:

- 1. Ratings
- 2. Number of poles

1. Ratings

Every circuit breaker has specific ampere, voltage, and interrupting ratings. The Ampere Rating is the breaker's continuous current-carrying capability. In most cases, the ampere rating should not exceed the current-carrying capacity of the circuit. For example, if a conductor is rated at 10 amps, select a circuit breaker no larger than 10

amps. Ampere ratings for miniature circuit breakers range from 10 to 150 amps. There are some specific circumstances when the ampere rating is permitted to be greater than the current-carrying capacity of the circuit. For example, motor and welder circuits can exceed conductor ampacity. The Voltage Rating of a circuit breaker must be at least equal to the circuit voltage. It can be higher than the circuit voltage, but never lower. For example, a 480-volt breaker can be used in a 240-volt circuit. However, a 240-volt breaker could not be used in a 480-volt circuit. Voltage ratings for miniature circuit breakers are 120/240-volt and 240-volt. A circuit breaker is also rated according to the level of fault current it can interrupt. This is referred to as Ampere Interrupting Capacity (AIC) (also called "interrupting rating"). In an application, a breaker must be able to interrupt the circuit's maximum short circuit current (without damaging itself). Interrupting ratings for miniature circuit breakers are 10, 22, 42, and 65 KAIC (thousand amps interrupting capacity).

2. Poles

Miniature circuit breakers are typically available in Single Pole, Double Pole, and three pole types. A pole is a hot conductor. It is a space in a load center, panel board, or similar device where a breaker can be attached. A single pole breaker disconnects one conductor, and a double pole breaker disconnects two conductors. A three pole breaker is typically used in industrial applications.

Single pole breakers are associated with 120 volts, while double pole breakers are associated with 240 volts. (For more detail on this subject, refer to Module 10, Load centers.).Miniature circuit breaker poles are generally one inch in width. However, some residential type breaker designs allow two poles to fit in the standard one-inch space. This breaker type is called a Duplex Circuit Breaker (or "half-size branch circuit breaker"). Twice as many protective devices fit in the same amount of available space, with the same ampere rating and without sacrificing protection or features (Figure 2.11). However, these narrow design configurations have current, voltage, and interrupting capacity limitations.



Figure 2.11 1/2 Inch per Pole and 1 Inch per Pole Circuit Breakers, Same Ampere Rating (1/2 Inch on Left)

2.4.2.2 Insulated Case Circuit Breakers (ICCB)

This type of circuit breaker is assembled on a metal frame contained within an insulated case and is provided with air break contacts. These types of circuit breakers are used as a part of larger installations such as switchboards and MCC type switchgear. Their components are larger and heavier for severe duty applications.

The insulated case circuit breaker typically has a high short time withstand and high interrupting rating. They are available today with both a local and a remote means of communication for setting of the various values, and facilitate such tasks as remote monitoring of electrical energy consumption and troubleshooting.

2.4.2.3 Molded Case Circuit Breaker (MCCB)

The most common type of re-settable over current protective device is the molded case circuit breaker. The case functions as both an outer wrapper and to retain in proper position the breaker's internal components. These cases are made from various types of electrical insulating and fire retardant plastic. Cases are typically not hermetically sealed; this allows them to be subject to corrosion from environmental factors. They are limited to 600 volts and less. They are typically available in single, two, or three pole models.

2.4.2.4 Microcomputer Circuit Breakers

For breakers in sizes above about 500 amps, the need to tailor the breaker's response increases to the point that a microcomputer-based circuit breaker becomes economical. Load profiles in many commercial/industrial facilities tend to change over time and the ability to tailor a breaker's specific performance aids in improving the level and types of protection provided for both people and electrical equipment. Other types of Breakers:

- RCD—Residual Current Device (formerly known as a Residual Current Circuit Breaker) detects current imbalance. Does NOT provide over current protection.
- RCBO—Residual Current Breaker with Over current protection combines the functions of an RCD and an MCB in one package. In the United States and Canada, panel-mounted devices that combine ground (earth) fault detection and over current protection are called Ground Fault Circuit Interrupter (GFCI) breakers; a wall mounted outlet device providing ground fault detection only is called a GFI.
- ELCB—Earth leakage circuit breaker. This detects earth current directly rather than detecting imbalance. They are no longer seen in new installations for various reasons.
- Poly switch (poly fuse) a small device commonly described as an automatically-resetting fuse rather than a circuit breaker.

Ground Fault Circuit Interrupter (GFCI)-This breaker has a solid state trip unit. It detects ground currents (which are small short circuits from one phase to ground), and trips to protect both people and equipment.



Figure 2.12 GFCI Breakers

2.5 Socket Outlet Circuits

There are two main types of circuits used in connecting sockets. Those are: ring circuits and radial circuits.

2.5.1 Ring Circuit

Most modern socket circuits are ring circuits or ring mains as they are sometimes referred to. A cable leaves the consumer unit and travels to each socket on the main and when it reaches the last socket it then returns to the consumer unit, thus creating a ring. The advantage of this system is that power can reach the sockets in the circuit from both directions, which reduces the power load on the cables.

A ring circuit can serve an area up to 110 square meters (120 square yards), 2.5mm2 cable is used to wire the circuit and the circuit has a 30amp fuse or 32amp MCB on the consumer unit. It is usual for a house to have one ring circuit upstairs and one ring circuit downstairs.

Ring circuits can have extra sockets added to them by adding a 'spur' onto a ring circuit. A spur is a branch off the ring circuit, usually from an existing circuit, although a junction box could also be used. Theoretically as many spurs as sockets could be added, but the maximum load of the circuit (30/32amp) still exists.



Figure 2.13 Connection of a ring power circuit

2.5.2 Radial Circuit

With radial circuits the cable comes from the consumer unit and travels to each socket, similar 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 2.5mm2 cable combined with a 20amp fuse/MCB an area of 20 square metres (24 square yards) is permissible. For 4mm2 cable combined with a 32amp MCB or a 30amp cartridge fuse (a rewirable 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.



Figure 2.14 connection of a radial power circuit

2.6 Lighting Circuits

Lighting circuits may include fixed lighting units, like ceiling pendants and uplighters, and outlets for flexible lighting systems (like track lighting). These circuits are often more complicated to construct, because they include a switch. In theory, the wiring of a lighting circuit can be viewed as figure 3.



Figure 2.15 A theoretical lighting circuit with switches

As can be seen from the figure, the switch is on the live and not on the neutral part of the circuit. This ensures that the light fitting is safe when the switch is off (so, for example, the bulb can be changed without risk of electrocution).

In practice it would be very difficult to wire a lighting circuit like figure 3, because the live and neutral cables are separate. In addition, an earth connection is needed at each switch, and each light fitting, for safety reasons (not shown on diagram). Normally we use two-core-and-earth cable for domestic wiring, so by convention the wiring of a lighting circuit is as shown in figure 2.16



Figure 2.16 A more practical lighting circuit

Apart from only showing two lights rather than three, this configuration is identical to figure 3, although it looks more complex. This additional complexity is to ensure that all connections can be made with two-core-and-earth cable. The central point for each light fitting is a junction box with four terminals. There are two ways to implement this junction box. First, a specific four-terminal lighting junction box can be used . The junction box will normally be concealed in a ceiling or floor void. Second, an integrated ceiling rose can be used, where the terminal blocks are part of the rose body. The rose connects the pendant lamp holder, and hides all the connections. For

simplicity, the rose will often be supplied with exactly the right number of terminals to accommodate all the cable connections. That is, there will be two blocks of three terminals, one block of two, and one block of four (for the earth wires).

One important point to note about the standard lighting circuit is that when the switch is on, both wires (red and black) to the switch are live. If this situation (a black live wire) is found to be unpalatable, one can buy a two-core-and-earth cable with two red conductors. Alternatively - at much lower cost - a small red marker (e.g., red insulating tape) could be wrapped around the black wire wherever it is visible.

When integrated ceiling roses are used throughout a circuit, this is called a `loop-in' configuration. Note, again, that the only connections are inside the fittings; there are no concealed junction boxes.

Lighting circuits are usually wired with 1.5 mm^2 cable, although 1 mm^2 is not uncommon. In conditions where the cable is entirely enclosed in wall plaster, at 30 degrees Celsius even the smaller of these two cables has a current carrying capacity of 11 amps: still well below the likely load imposed by a standard lighting circuit (11 amps will support more than twenty 100-watt light bulbs). However, if the cable run is long, it is more likely to exceed the maximum voltage drop regulation. In a worst-case configuration (a long cable with maximum allowable current drawn at the far end) it turns out that a 1 mm² cable can be about 35 meters long before this happens. If the cable is longer than that, a larger cable is needed.

Lighting circuits are not normally wired as a ring system, because the total current requirement rarely even approaches the capacity of the cable.

2.7 Distribution Board

An assembly containing switches or protective devices, such as; fuses, circuit breakers, residual current operated devices. A fuse box is a particular type of distribution board. Distribution boards consist of an assembly for the control and distribution of electricity, incorporating manual means for isolation of the incoming circuit and an assembly of one or more fuses and circuit breakers and other devices.

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Figure 2.17 Fuse box

A = Main switch B = Circuit breakers C = Residual current device

CHAPTER 3: ILLUMINATION CALCULATIONS

3.1 Lighting Calculations

The total light flux is equal to the area of the room multiplied by the standard illumination level. That is:

$$\phi_t = \frac{E \times S}{m \times \eta}$$

Where:

 ϕ_t : Total light flux

E: Standard illumination level

S: Area of the surface

m: Dirtiness factor

 η : Utilization factor (Multiplication factor)

 η Can be find by using the tables if the color of the wall, ground and ceiling are known and the room index is calculated.

The number of armatures needed to be installed in a room can be calculated by using the following formula

$$N = \frac{\phi_t}{\phi_A \times Z}$$

Where:

N : Number of armatures

 ϕ_t : Total light flux

 ϕ_A : Light flux of the lamp

Z: Number of lamps in the armature

The room index factor is equal to the area of the room divided by the length added to the width and multiplied by the distance from the light source to the working plane. That is:

$$K = \frac{A \times B}{(A+B) \times H}$$

Where:

A: The length of the room

B: Width of the room

H: Distance between the light source and working plane

$$H = h_1 - \left(h_2 + h_3\right)$$

 h_1 : Height of the room

 h_2 : Height of the working plane

 h_3 : Hanging distance of the light source

If K (Room index) is calculated and the color of the walls, ceiling and ground are known then η could be found from the table 3.1

Ceiling	0.80			0.50			0.30			
Wall	0.5	50	0.3	30	0.5	50	0.3	30	0.10	0.30
Ground	0.30	0.10	0.30	0.10	0.30	0.10	0.30	0.10	0.30	0.10
$K = \frac{A \times B}{(A+B) \times H}$	Room 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

Table 3.1 Room illumination efficiency [1]

Taking the computer lab in block H as an example:

E = 500lx (Selected according to the electrical installation standards) A = 7.92m B = 7.915m $h_1 = 3m$ $H = h_1 - (h_2 + h_3)$ H = 3 - (0.8 + 0.0) = 2.2m $K = \frac{A \times B}{(A + B) \times H}$ $K = \frac{7.92 \times 7.915}{(7.92 + 7.915) \times 2.2} \approx 1.8$ The Ceiling is white (0.8), walls are quite white (0.5) and the ground is medium dark (0.3).

Using the linear interpolation formula

Index	Efficiency	
$x_1 = 1.5$	$y_1 = 0.45$	
$x_2 = 1.8$	y ₂ = ?	$y_2 = y_1 + \frac{x_2 - x_1}{x_3 - x_1} (y_3 - y_1)$
$x_3 = 2$	$y_3 = 0.51$	
	1	

$$y_2 = 0.45 + \frac{1.8 - 1.5}{2 - 1.5}(0.51 - 0.45) = 0.486$$

$$\phi_t = \frac{500 \times 62.6868}{0.486 \times 0.8} = 80615.74074lm$$

$$N = \frac{80013.74074m}{1750lm \times 4} \approx 12$$

3.2 Voltage and Current Calculation Formulas

3.2.1 Voltage Calculation Formula

• For Single Phase

$$\%e = \frac{200 \times L \times N}{X \times S \times U_n^2} < 1.5$$

• For Three Phase

$$\%e = \frac{100 \times L \times N}{X \times S \times U_n^2} < 3$$

Where:

e%: Voltage calculation (percent).

N: Power (KW).

L: Length of the line (m).

 U_n : Operating voltage.

X : Conductive coefficient where X (cu) =56 m/ Ω mm², X (Al) =35m/ Ω mm²

3.2.2 Current Calculation Formula

• For Single phase

$$I = \frac{P}{V \times COS\phi}$$

• For Three phase

$$I = \frac{P}{V \times COS\phi \times \sqrt{3}}$$

Where:

V : Voltage.

P: Power (KW).

I : Current.

CONCLUSION

The interior electrical installation of the Near East University's library was designed in this project. Electrical installation is a very wide field and there are many ways to meet the standard installation requirements. That's why different electrical engineers can have different designs for the same project. It is in a way limited to the designer's creativity.

The best design would definitely be the one that meets the standard electrical installation requirements at the lowest cost, taking into consideration the power consumption and the decorative side of installation.

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