INDUSTRIAL ELECTRICAL MACHIN DRIVE TECHNOLOGY
LEVEL II

LEARNIG GUIDE- 17

Unit of Competence:	**Install and terminate wiring system**
Module Title:	**Installing and terminating wiring system**
LG Code:	**EEL EMD2 05 0811**
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LO2: Perform installation and termination of wiring system

Instruction Sheet 1	Learning Guide # 17

MODULE CONTENTS:

LO2: Perform installation and termination of wiring system

- OHs Police and Procedure
- Types of diagram
- Installing Wiring system standard and code
- Terminating and connecting accessories
- Installing wiring system
- Responding Unplanned events or conditions
- Approving procedure and requirement of termination

This guide will also assist you to attain the learning outcome and contents stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Identify Safety requirements of equipment/tools
- Reading and interpreting electrical circuit diagrams
- Identify Types and application of termination
- Perform Procedure of termination
- Identifying wiring system components and accessories

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instruction described blew 3 to 6
3. Read the information written in the “Information Sheet 1 up to information 7”.
4. Accomplish the “Self-check 1, self-check 2, Self-check 3, Self-check 4, Self-check 5, Self-check 6, Self-check 7 ” in page (6,13,21,24,28,30,and 33) respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1 up to operation sheet 4 in page -34, 35,36 and 37 respectively.
6. Do the “LAP test” in page – 38 (if you are ready.
7. Reference in page 39

Information Sheet-1	OHs Police and Procedure

1.1. OHS policies and procedures

Your Company Name is committed to the goal of providing and maintaining a healthy and safe working environment, with a view to continuous improvement. This goal is only achievable by adherence to established objectives striving to exceed all obligations under applicable legislation, and by fostering an enthusiastic commitment to health, safety and the environment within Your Company Name personnel, contractors and visitors.

In particular:

- Management, working in cooperation with the Joint Health and Safety Committee, will strive to take all reasonable steps to reduce workplace hazards to as low as reasonably achievable.
- Supervisors and managers are held accountable for the health and safety of all employees under their supervision. This includes responsibility for applicable training and instruction, appropriate follow-up on reported health and safety concerns, and implementation of recommended corrective action. This accountability is integrated into the performance appraisal system.
- Supervisors, workers and visitors are expected to perform their duties and responsibilities in a safe and healthful manner, and are accountable for the Health and Safety of themselves and others.
- Your Company Name is committed to providing all necessary training and instruction to ensure that appropriate work practices are followed on the job, and to promote their use off the job.
- If necessary, Your Company Name will take disciplinary action where individuals fail to work in a healthy and safe manner, or do not comply with applicable legislation or corporate policies and procedures.

What can you do to protect yourself and others from electrical hazards?

Employees can prevent shocks and injuries/electrocution from electrical hazards by:

- Following safe work practices
- Understanding electric shock and electro caution
- Recognizing potential hazards around work involving electricity
- Following OHS requirements
- Maintaining clearances around panels
- Using proper protective devices
- Eliminating access to exposed energized parts Using proper PPE
- Using proper lockout/tag out procedures
- Maintaining proper clearance from overhead lines

- Following proper procedures for confined space/enclosed space/underground electrical work
- Following manufacturer's instructions

When you have to do maintenance work on a machine, take these four steps to protect yourself and your coworkers from injury:

1. De-energize the machine. Positively disconnect it from the power source. If there is more than one source of power, disconnect them all.
2. Lock out the disconnect switches. You must be given a lock and key for each disconnect before you begin working on the machine
3. Tag the disconnect switches. Get tags or accident prevention signs from your supervisor.
4. Test the machine to make sure it won't start and Keep the key with you

Each worker who works on the machine must lock out and tag the power disconnect. Never assume that the machine you are working on has been disconnected and Locked out unless you have done it yourself. Also remember that the current ratings off use and circuit breakers are at 15 to 30amperes for most residences. These safeguards cannot protect you against shocks. High voltage transmission and distribution lines carry a lot of electricity and if accidently touched it can be fatal. Since farm and construction workers use equipment that can reach high, these employees must be trained on the hazard supposed by high voltage overhead lines. Each year, workers who accidentally make contact with high voltage power lines are either killed or become permanently disabled. Electrically powered equipment is used daily by most workers. Power tools, metal and woodworking machines, restaurant equipment, computers and many other types of electrical equipment are found in the workplace. Failure to use the equipment correctly can create hazards to employees. Generally, there are instructions from the manufacturers on the use and maintenance of each piece of equipment. Workers need to follow the instructions while using and

- Replace broken 3-prong plugs and make sure the third prong is properly grounded.
- Never use extension cords as permanent wiring.
- Do not plug several power cords into one outlet.
- Do not disconnect power supplies by pulling or jerking the cords from the outlets.
- Always use the correct size fuse or breaker.
- Be aware that unusually warm or hot outlets may be a sign that unsafe wiring conditions exists.
- Use proper PPE for the electrical job.
- Always use ladders made of wood or other non-conductive materials when

Working with or near electricity or power lines

1.2 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) is anything used or worn by a person to minimize risk to the person's health or safety and includes a wide range of clothing and safety equipment. PPE includes boots (safety shoes, face masks, hard hats (helmet), ear plugs, respirators, gloves, safety harnesses and high visibility clothing.

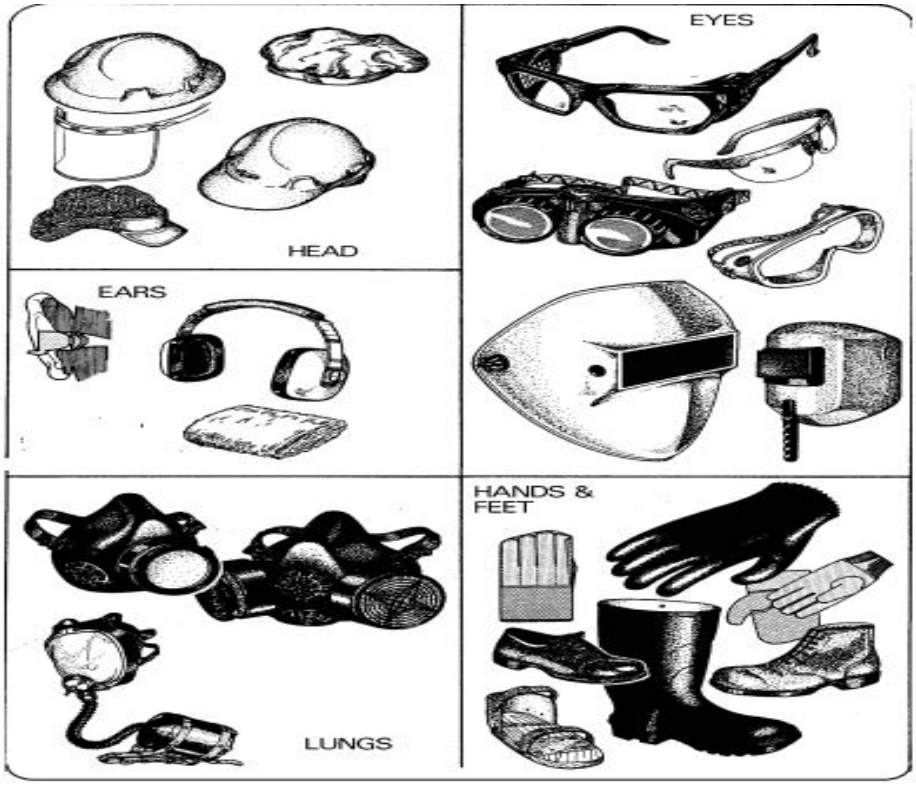


Fig1-1 Types of PPE

- **SAFETY SHOES**

Some safety shoes are designed to limit damage to your toes from falling objects. A steel plate is placed in the toe area of such shoes so that your toes are not crushed if an object impacts there. Other safety shoes are designed for use where danger from sparking could cause an explosion. Such danger is minimized by elimination of all metallic nails and eyelets and by the use of soles that do not cause static electricity.

- **GOGGLES**

Proper eye protection is of the utmost importance for all personnel. Eye protection is necessary because of hazards posed by infrared and ultraviolet radiation, or by flying objects such as sparks, globules of molten metal, or chipped concrete and wood. These hazards are ever-present during welding, cutting, soldering, chipping, grinding, and a variety of other operations. It is IMPERATIVE for you to use eye protection devices, such as helmets, face shields, and goggles (fig. 1-1), during eye-hazard operations.

Appropriate use of goggles will limit eye hazards. Some goggles have plastic lenses that resist shattering upon impact. Others are designed to limit harmful infrared and ultraviolet radiation from arcs or flames by use of appropriate filter lenses.

Remember, eye damage can be excruciatingly painful. PROTECT YOUR EYES.

- **GLOVES**

Use gloves ((fig. 1-1) whenever you are required to handle rough, scaly, or splintery objects. Special flameproof gloves are designed for gas and electric-arc welding to limit danger and damage from sparks and other hot flying objects Personnel in the electrical fields are usually required to wear insulating rubber gloves. Be sure to follow all regulations prescribed for the use of gloves. Gloves must not be worn around rotating machinery unless sharp or rough material is being handled. If such is the case, EXTREME CARE SHOULD BE EXERCISED to prevent the gloves from being caught in the machinery.

- **SAFETY BELTS AND STRAPS**

The safety strap and body belt shown in figure 1-1 are what might be called your extra hands when you work aloft. The body belt, strapped around your waist, contains various pockets for small tools. The safety strap is a leather or neoprene-impregnated

nylon belt with a tongue-type buckle at each end. While you are climbing you will have the safety strap hanging by both ends from the left ring (called a D-ring because of its shape) on the body belt. When you are at working position, you unsnap one end of the safety strap, pass it around the supporting structure so there is no danger of its slipping (at least 18 inches from the top of the part on which it is fastened), and hook it to the right D-ring on the body belt.

The safety strap must be placed around a part of the structure that is of sufficient strength to sustain an Abs weight and his or her equipment, and must rest flat against the surface without twists or turns. It must not be placed around any part of a structure that is being removed. Before placing your weight on the strap, determine VISUALLY that the snap and D-ring are properly engaged. Do not rely on the click of the snap-tongue as an indication that the fastening is secure. The body belt and safety strap require inspection before use. Look for loose or broken rivets; cracks, cuts, nicks, tears or wear in leather; broken or otherwise defective buckles, such as enlarged tongue-holes, defects in safety-belt snap hooks and body belt D-rings. If you discover any of these or other defects, turn in your equipment and replace it. Perform maintenance periodically according to applicable procedures. Remember that leather and nylon belts are treated in different manners.

When can PPE be used?

PPE is one of the least effective ways of controlling risks to work health and safety and should only be used:

• when there are no other practical control measures available (as a last resort)

• as an interim measure until a more effective way of controlling the risk can be used, or

• to supplement higher level control measures (as a back-up).

What standard of PPE is required?

PPE used at a workplace must be:

• selected to minimize risk to work health and safety

• suitable for the nature of the work and any hazard associated with the work

• a suitable size and fit and reasonably comfortable for the person wearing it

• maintained, repaired or replaced so it continues to minimize the worker's health and safety risk, and

• used or worn by the worker, so far as is reasonably practicable.

How do I choose the right PPE for the job?

Selection processes for choosing the right PPE must involve consultation with workers and their representatives and should also include:

• a detailed evaluation of the risk and performance requirements for the PPE

• compatibility of PPE items where more than one type of PPE is required (for example ear muffs with a hard hat)

• Consultation with the supplier to ensure PPE is suitable for the work and workplace conditions, and

preference for PPE that complies with the relevant Ethiopian Standard or equivalent standard.

Self-check: 1	Written test

Name…… Date……

Direction I. Say true or false for the following questions

1. Supervisors and managers are held accountable for the health and safety of all employees under their supervision.
2. selected to minimize risk to work health and safety is one of standard of PPE required

Direction II. Choose best answer

1. Employees can prevent shocks and injuries/electrocution from electrical hazards by:
   A. Following safe work practices
   B. Maintaining clearances around panels
   C. Using proper protective devices
   D. All
2. Which one of the following is the **first** requirement to do maintenance work on a machine to protect yourself and your coworkers from injury:
   A. De-energize the machine.
   B. Lock out the disconnect switches.
   C. Tag the disconnect switches.
   D. Test the machine to make sure it won't start and Keep the key with you
3. ……. Is a type of personal protective device which used to protect Eye from hazards posed by infrared and ultraviolet radiation, or from flying objects such as sparks.
   A. GLOVES
   B. GOGGLE
   C. Safety shoes
   D. All

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5points**

Information Sheet 2	Types of diagram

Types of electrical diagram

- Schematic diagram
- Pictorial diagram
- Wiring diagram
- Layout diagram

For detail information refer / Learning guide#1 information sheet 2/

Information Sheet 3	Installing Wiring system standard and code

3.1 Lighting Requirements

The Ethiopian Building Code Standard (EBCS-10) must be followed at all times concerning every electrical design, installation and repair; whether in commercial, industrial or residential buildings.

Lighting Requirements (EBCS under Sec 3. Illumination)

The recommended luminance for different types of interiors, tasks and workspaces are given in Table 3.5 and Table 3.6 shall be taken as the recommended minimum values on which the design and assessment of lighting installations are to be based.

1. **Lux** can be used as a measure of the brightness of a light source. Lamp illumination and design in any indoor and outdoor workplaces are expressed in lux. One lux is equal to one lumen per square meter: 1 lux = 1 lumen/m^2

2. **Lumen** is a measure of the total amount of visible light emitted by a source. It is the SI derived unit of luminous flux. A flux of 1,000 lumens, concentrated into an area of one square meter, lights up that square meter with an illuminance of 1,000 lux. However, the same 1,000 lumens, spread out over ten square meters, produce a dimmer illuminance of only 100 lux.

   Therefore, the difference between units lumen and lux is that the lux takes into account the area over which the luminous flux is spread.

3. Common Fluorescent lamp and their average Lumen output

Table 1

Type of Fluorescent lamp	Lumen Output	Average Lumen per watt
4 feet Linear 25 Watt T8	2209 lumens	88 lumens per watt
4 feet Linear 28 Watt T5	2900 lumens	104 lumens per watt
4 feet Linear 32 Watt T8	2850-3100 lumens	93 lumens per watt
4 feet Linear 34 Watt T12	1930-2800 lumens	70 lumens per watt
4 feet Linear 40 Watt T12	1980-3300 lumens	66 lumens per watt
4 feet Linear 54 Watt T5	5000 lumens	93 lumens per watt

Achieving an illuminance of 500 lux might be possible in a 24m^2 house area with four fluorescent light fixture with a combined output of 12,000 lumens. To light a factory floor with dozens of times the area of the house would require dozens of such fixtures. Thus, lighting a larger area to the same level of lux requires a greater number of lumens. The ordinary four feet Linear Fluorescent Bulbs, 40-watt, 220V, T12 has an output average of 2600 lumens.

Example:
What would be the total number of 40-watts, 220V, T12 fluorescent lamp fixtures to be installed in a 50 m^2 area of school library if it requires having a 300 lux illumination?

Given: Lux = lumen / m^2 Lux = 300 lamp = 2600 lumens per 40-watt F.L. Lumen =?

Solution: Lumen = (Lux) (Floor area in m^2)
Lumens = (300 lux) (50 m^2)
= 15, 000 lumens
Lamp = 15, 000 lumens/(2600 lumens per 40-watt F.L .)
= **5.8** or **6** set of 40-watts fluorescent lamp

Here are some examples of the Workplaces recommended illuminance provided by EBCS -10

table 2 the Workplaces recommended illuminance

Type of indoor /outdoor workplaces		**Rated Illuminance in Lux**
Hotels and restaurants	Kitchen Dining room	500 200
	Conference room	300
School or educational establishment	Reception Classroom/teaching room Laboratories/demonstration room	200 300 500
	Technical drawing room Corridors	700 100
	Staircases	100
Hospital	Libraries Canteens Infant ward general lighting	300 200 200
	Bedded area/ward Toilets Therapy rooms general lighting	100 100 300
Offices and similar rooms	Offices	500
	Reception rooms Conference and consultation	100 300

	rooms	
Wood working shop	Saw mils Bench work, gluing, assembly Pattern making, polishing, varnishing Checking for defects Gates	200 300 500 750 50
Outdoor workplace	Parking areas	3
	Roofed bicycle area Foot paths	20 5

3.2 Conductors and Over load protection Requirements

3.2.1 Size of Conductors

The minimum nominal cross-sectional area of conductor shall be:

a) 1.0mm^2 for cables and insulated copper conductors for power and lighting circuits;
b) 10.0mm^2 for bare copper conductors for power circuits;
c) 16.0mm^2 for bare aluminum conductors for power circuits
d) 0.5mm^2 for flexible cables of copper conductors for extra low voltage.

3.2.2 Neutral Conductors

For a poly-phase circuits in which imbalance may occur in normal service, the neutral conductor shall have a cross-sectional area adequate to carry the maximum connected load between the neutral and anyone ungrounded conductor. In a discharge lighting circuit, the neutral conductors shall have a cross-sectional area not less than that of the· phase conductor(s).

3.2.3 Voltage Drop – describes how the supplied energy of a voltage source is reduced as electric current moves through the passive elements of an electric circuit.

The size of conductors shall be, such that the voltage drop between the supply terminal and fixed current using equipment shall not exceed 4% of the nominal voltage of the supply line, when the conductors are carrying the full load current.

For instance if the supply voltage is 230V, then 4% of 230V is 9.2V, therefore the allowed *Voltage drop* should not exceed to *9.2V*.

For single phase circuit; to calculate the voltage drop (in mV) the tabulated value (see: EBCS Table B.2) for the cable concerned has to be multiplied by the length of the run in meters and by the current the cable is intended to carry; namely, the design current of the circuit (I_b) in amperes. Voltage drop = [(mV /A/m) (length of wire) (I_b)]

Example:

Compute the voltage drop of a 2.5 mm^2 multi-core pvc armored sheath insulated wire installed in a PVC conduit. The circuit design current is 15A

and it has a 10-m long run from the circuit breaker to the current using equipment

Given:

Length of wire = 10 m Size of wire = 2.5 mm^2 I_b = 15A

Tabulated voltage drop of 2.5 mm^2 = 18 mV/A/m (EBCS- Table B.2 pp.91)

Voltage drop = [(mV /A/m) (length of wire) (I_b)]

Solution:

Voltage drop = [(18mV/A/m)(10m)(15A)] = **2700mV** or **2.7V**

Table 3 Voltage drop (per ampere per meter)

Conductor operating temperature: 70°C

Conduct or cross-sectional area	**2 cables dc**	**2 cables –single phase A.C.**			**3 or 4 cables-three phase A.C.**			
		Reference Method 3 & 4(enclosed in conduit)	Reference Method 1 & 11 (clipped/ direct on trays touching)	Reference Method 12 (spaced)	Reference Method 3 & 4 (enclosed in conduit)	Reference Method 1 & 11 (trefoil)	Reference Method 1 & 11 (flat & touching)	Reference Method 12(flat spaced)
1 mm^2	2 mV	3 mV	4 mV	5 mV	6 mV	7 mV	8 mV	9 mV
1	44	44	44	44	38	38	38	38
1.5	29	29	29	29	25	25	25	25
2.5	18	18	18	18	15	15	15	15
4	11	11	11	11	9.5	9.5	9.5	9.5
6	7.3	7.3	7.3	7.3	6.4	6.4	6.4	6.4
10	4.4	4.4	4.4	4.4	3.8	3.8	3.8	3.8
16	2.8	2.8	2.8	2.8	2.4	2.4	2.4	2.4

3.2.4. Flexible Cords

Flexible cords may be used for:

a) Electrical equipment for household or similar use having a rating of 16.0A or less at voltages not exceeding 230.0V and which is intended to be moved from place to place.

b) Electrical equipment for industrial use which must be capable of being moved from place to place for operation

c) Pendants

d) The connection of stationary equipment

e) The connection of electrical components between which relative motion is necessary

f) The connection of appliances such as ranges and clothes dryers;

g) Supplying of current for portable lamps and other devices

h) Wiring of cranes and hoists.

Flexible cord shall not be used for:

- As substitute for fixed wiring
  - ✓ Permanently secured to any structure
  - ✓ Run through holes in walls, ceilings or floors
  - ✓ Run through doorways, windows or similar openings
- At temperature above the rating of the cord
- For suspension of any device weighing more than 2.3kg unless the cord and the device assembly are marked as capable to support a weight up to 11kg.

3.2.5 Color of Conductors

Table 4 Color identification of Cores for Flexible cables and cords

Number of Cores	***Function of Core***	***Color of Core***
1	Phase	Brown
	Neutral	Blue
2	Protective	Green and yellow
	Phase	Brown
	Neutral	Blue
3	Phase	Brown
	Neutral	Blue
	Protective	Green and yellow
4 or 5	Phase	Brown or Black
	Neutral	Blue
	Protective	Green and yellow

Table 5 Color identification of Cores for Non-Flexible cables and bare conductor for fixed wiring

Function	***Color Identification***
Protective conductor (ground)	Green and yellow
Phase conductor of 1-phase circuit AC	Red or Yellow or Blue
Neutral conductor of 1-phase circuit AC	Black
Phase conductors of 3-phase circuit AC (R,Y,B)	Red / Yellow / Blue
Positive conductor of DC 2-wire circuit	Red
Negative conductor of DC 2-wire circuit	Black
Positive conductor of DC 3-wire circuit	Red
Middle conductor of DC 3-wire circuit	Black
Negative conductor of DC 3-wire circuit	Blue

3.2.6 Correction Factor of Conductors

The current carrying capacity of a conductor for continuous duty is affected by *ambient temperature*, *grouping*, *thermal insulation,* semi-enclosed fuses and *frequency*.

- **Ambient temperature correction factors (C_a)**
- **Cable grouping correction factors (Cg)**
  - ✓ Widely spaced cables dissipate heat easily
  - ✓ A closely packed cable cannot easily dissipate heat and so its temperature rises Because of this, cables installed in groups with others (for example, if enclosed in a conduit or trunking) are allowed to carry less current than similar cables clipped to, or lying on, a solid surface which can dissipate heat more easily

- **Thermal insulation correction factors (Ci)**
  ✓ The use of thermal insulation in buildings, in the forms of cavity wall filling, roof space blanketing, and so on, is now standard. Since the purpose of such materials is to limit the transfer of heat, they will clearly affect the ability of a cable to dissipate the heat buildup within it when in contact with them.

Steps in cable/wire size computation

- Calculate the expected (design) current in the circuit (I_b)
- Choose the type and rating of protective device (fuse or circuit breaker) to be used(I_n)
- Divide the protective device rated current by the ambient temperature correction factor (C_a) if ambient temperature differs from 30°C
- Further divide by the grouping correction factor (C_g)
- Divide again by the thermal insulation correction factor (C_i) if applicable
- Divide by the semi-enclosed fuse factor of 0.725 where applicable
- The result is the rated current of the cable required, which must be chosen-from the tabulated current carrying capacity (I_t) given in the Tables under Section 4. of EBCS -10.

3.3 Over-current protection Requirements

Over-current Protective Device (EBCS under Sec 9. Protection and Control)

Every electrical apparatus and unearthed conductors shall be protected by one or more devices as may be necessary for automatic and/or manual interruption of the supply in the event of any fault and shall be provided with:

- protection against fault current
- protection against overload current
- protection against under voltage
- protection against earth fault
- manually-operable control device

3.3.1 Over-current devices –
the safety device that provide over-current protection of either the load or source circuit. The over-current protective devices shall ensure safe operation and shall have interrupting capacity sufficient for the voltage employed and for the anticipated fault current which must be interrupted. The rating or setting of over-current devices shall not exceed the allowable ampacity of the conductors which they protect except:

- If the rating of the fuse of circuit breaker is not available the ratings or settings given in may be used;
- In case of equipment wire, flexible cord or tinsel cord which will be considered as being protected by 16.0 A over-current device.

Fuse – is a type of very low resistance conductor that provides over-current protection through a metal strip that melts when too much current flows on it.

(EBCS 9.5) – Only fuses and fuse holders of proper rating shall be used, and no bridging or short circuiting of either component shall be permitted. Where plug fuses are used in branch circuits, they shall be of such a type and so installed that they are non-interchangeable with a fuse of larger rating

A fuse having a fuse link which is likely to ·be removed or replaced while the supply is connected shall be of a type such that it can be removed or replaced without danger.

Circuit breaker – is an automatically operated electrical switch designed to protect an electrical circuit from damage cause by overload or short circuit. Some circuit breaker has bi-metallic element that can detect a fault condition or over-current flow which will drive the breaker into trip off position resulting to interruption of the current flow.

- Circuit breakers shall be of the trip-free type.
- Indication shall be provided at the circuit breaker and at the point of operation to show whether the circuit breaker is open or closed.
- Circuit breakers shall open the circuit in all unearthed conductors by the manual operation of a single handle and by the action of over-current.
- Circuit breakers shall be of such design that any alteration by the user of either the tripping current or the time will be difficult.

2. Earth Fault Protection (EBCS 9.4.2) – Earth-fault protection shall be provided to de-energize all normally earthed conductors of a faulted circuit in the event of an earth fault in those conductors.

3. Control Devices (EBCS 9.7) Control devices shall have ratings suitable for the connected load of the circuits which they control and with the exception of isolating switches, shall be capable of safely establishing and interrupting such loads.

- Control devices used in combination with over-current devices or overload devices for the control of circuits or apparatus shall be connected so that the over-current or overload devices will be dead when the control device is in the open position, except where this is impracticable.
- Control devices, with the exception of isolating switches, shall be readily accessible.

- Control devices, unless located or guarded so as to render them inaccessible to unauthorized persons and to prevent fire hazards, shall have all current-carrying parts in enclosures of metal or other fire-resisting material.
- Where electrical equipment is supplied by two or more different transformers or other sources of voltage, then:
  (a) a single disconnecting means, which will effectively isolate all unearthed conductor supplying the equipment, shall be provided integral with or adjacent to the equipment;or
  (b) each supply circuit shall be provided with a disconnecting means integral with or adjacent to the equipment, and the disconnecting means shall be grouped together.

4. Switches – an electrical device that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. A switch can be manually operated or automatically activated.

- Single-throw knife switches shall be mounted with their bases in a vertical plane so that gravitational force will not tend to close them.
- Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal. (b) If the throw in (1) above is vertical, a positive locking device or stop shall be provide do ensure that the blades remain in the open position when so set unless it is not intended that the switch be left in the open position.
- Manual single-throw switches, circuit breakers, or magnetic switches, shall be connected so that the bases or moving contacts will be dead when the device is in the open position except when other conditions make this requirement unnecessary.

5. Protection and Control of Miscellaneous Apparatus (EBCS 9.8)

- Socket outlets shall not be connected to a branch circuit having over-current protection rated or set at more than the ampere rating of the socket outlets except as permitted by other Sections of this Code.
- Portable appliances need not be equipped with additional control devices where the appliances are:
  - ✓ Rated at not more than 1500 Watts; and
  - ✓ provided with cord connectors, attachment plugs or other means by which they can be disconnected readily from the circuits.
- Where switches are used to control an outlet or outlets from more than one point, the switches shall be wired and connected so that the earthed conductor runs directly to the outlet or outlets controlled by the switches.
- Except for panel boards where more than 90% of the over-current devices supply feeders or motor branch circuits, every panel board shall be protected on the supply side by over-current devices having a rating not greater than that of the panel board.

- Transfer equipment for standby power systems shall prevent the inadvertent interconnection of normal and standby sources of supply in any operation of the transfer equipment.

Table 6 Rating or setting of over-current devices protecting conductors

Ampacity of conductors	Rating or setting permitted (A)	
	Fuse	Circuit breaker
0-16	16	16
17-20	20	20
21-25	25	32
26-32	32	32
33-40	40	40
41-50	50	50
51-63	63	63
64-80	80	100
91-100	100	100
101-110	110	125
111-125	125	125
126-150	150	150
151-175	175	175
176-200	200	200
201-225	225	225
226-250	250	250
251-275	300	300
276-300	300	300
301-325	350	350
326-350	350	350
351-400	400	400
401-450	450	450
451-500	500	500
501-525	600	600
526-550	600	600
551-600	600	600

3.4 Circuit Loading and Demand Factor Requirements

- **Demand factor** – it is the ratio of the maximum demand of a system or part of a system, to the total connected load on the system, to the maximum demand of the whole system, or part of a system, under consideration.
- **Diversity factor** – the ratio of the sum of the individual maximum demands of the various subdivisions of a system, or part of a system, to the maximum demand of the whole system, or part of a system, under consideration.
- **Continuous load** – any condition in which the maximum load current in a circuit flows without interruption for a period of not less than 3 hrs.
- **Current calculation** – When calculating the currents from loads expressed in watts or volt-amperes, to be supplied by a low voltage A.C. system, the voltage divisor to be used shall be 230V or 380V as applicable.

- **Voltage drop** – voltage drop in an installation shall be based upon the calculated demand load of the branch circuits and shall satisfy the requirements of clause EBCS Sec 4.5.4.
- **Maximum circuit loading** – for loads other than motors, the total on consumer's service, feeder or a branch circuit shall be 80% of the circuit rating when the load is a continuous one.
- **Use of demand factor**
  - ✓ Where two or more loads are so installed that only one can be used at any one time, the one providing the greatest demand shall be used in determining the calculated demand.
  - ✓ Where feeder supplies loads of a cyclic or similar nature such that the maximum connected load will not be supplied at the same time, the ampacity of the feeder conductors shall be based on the maximum load that may be connected at any one time.
  - ✓ The ampacity of conductors of a feeder or branch circuit shall not exceed the ampacity of the conductors of 'the service or of the feeder from which they are supplied.

Self-check: 3	Written test

Name …… Date…….

<u>Direction</u> I Choose best answer for the following question

1. An automatically operated electrical switch designed to protect an electrical circuit from damage cause by overload or short circuit.
   A. Fuse *C.* switch
   B. Circuit breaker *D.* Control Devices
2. According to EBCS coding system in single phase supply the phase line should be
   A. Green C. Blue
   B. Yellow D. Brown
3. Which one of the following color is does **not** represent of live /phase/ in three phase supply
   A. Black C. Yellow
   B. Red D. Blue
4. Steps in cable/wire size computation
   A. Calculate the expected (design) current in the circuit (I_b)
   B. Choose the type and rating of protective device (fuse or circuit breaker) to be used(I_n)
   C. Divide the protective device rated current by the ambient temperature correction factor (C_a) if ambient temperature differs from 30°C
   D. All
5. Conductors and Over load protection Requirements
   A. Size of Conductors C. Voltage Drop
   B. Neutral Conductors D. All

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information Sheet 4	Terminating and connecting accessories

The required is to controlling one lamp from one positions by using one way switch controlling one lamp from one location by using single pole single though (SPTS) switch. As we see fig 1.2 the switch is used to on/off the lamp, if the switch is ON the lamp is ON and also if the switch is OFF the lamp gets OFF.
The phase line should be connect first with switch.

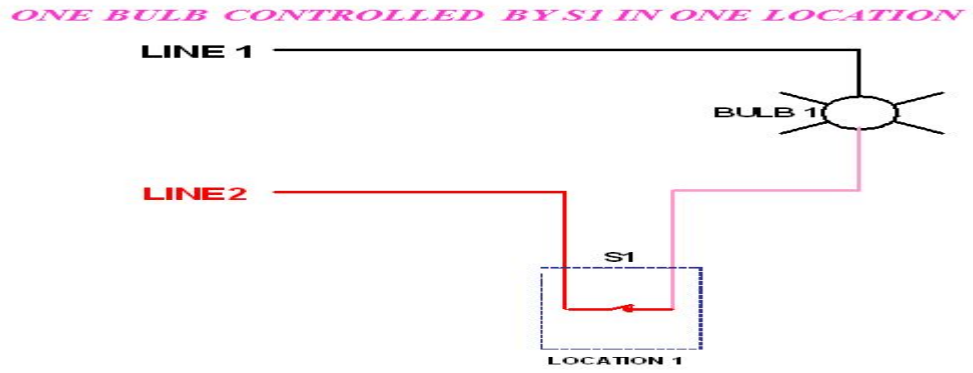


Fig 1.2

In the fig 1.3 required is to controlling two lamp from one positions by using one way switch controlling two lamp from one location by using single pole single though (SPTS) switch. As we see fig 1.3 the switch is used to on/off the lamps, if the switch is ON the lamps is ON and also if the switch is OFF the lamps gets OFF.

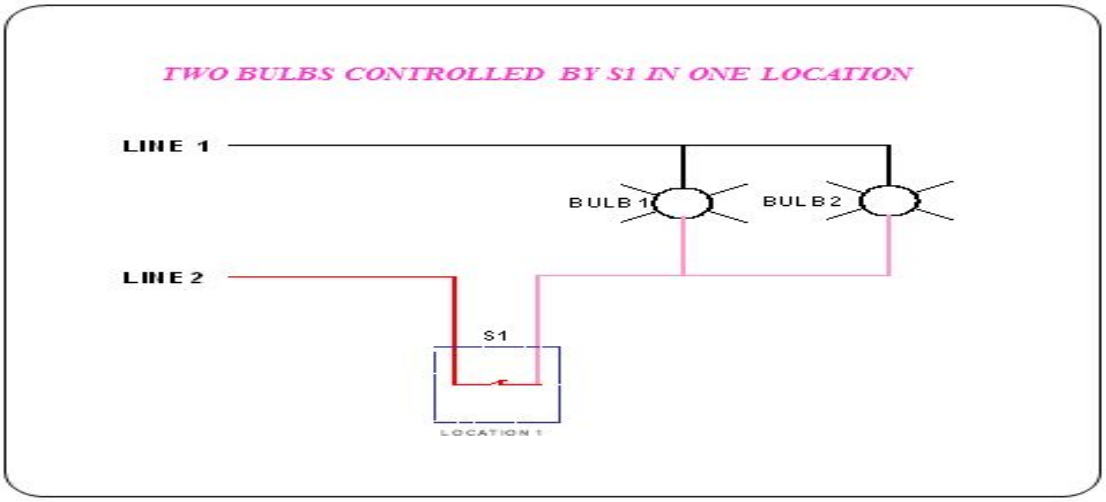


Fig 1.3

In the fig 1.4 required is to controlling one lamp from two positions by using two way switch controlling one lamp from two location by using two way switch. As we see fig 1.4 the switch 1 and switch 2 independently is used to on/off the lamp.

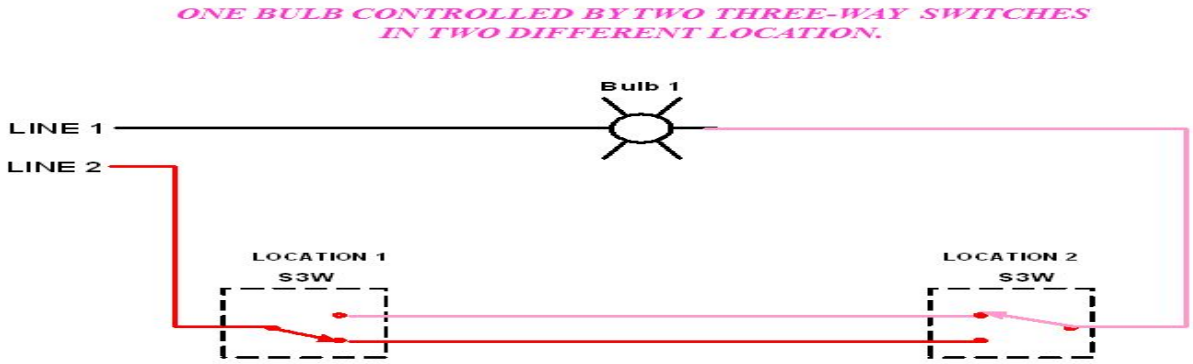


Fig 1.4

In the fig 1.5 required is to controlling one lamp from three positions by using two way switch and intermediate switch controlling one lamp from three location . The switch 1 , switch 2 and switch 3 independently is used to on/off the lamp. Switch 1and switch 3 are two way switch and switch 2 is intermediate switch.

ONE BULB CONTROLLED BY TWO THREE-WAY SWITCHES AND ONE FOUR-WAY SWITCH IN THREE DIFFERENT LOCATION.

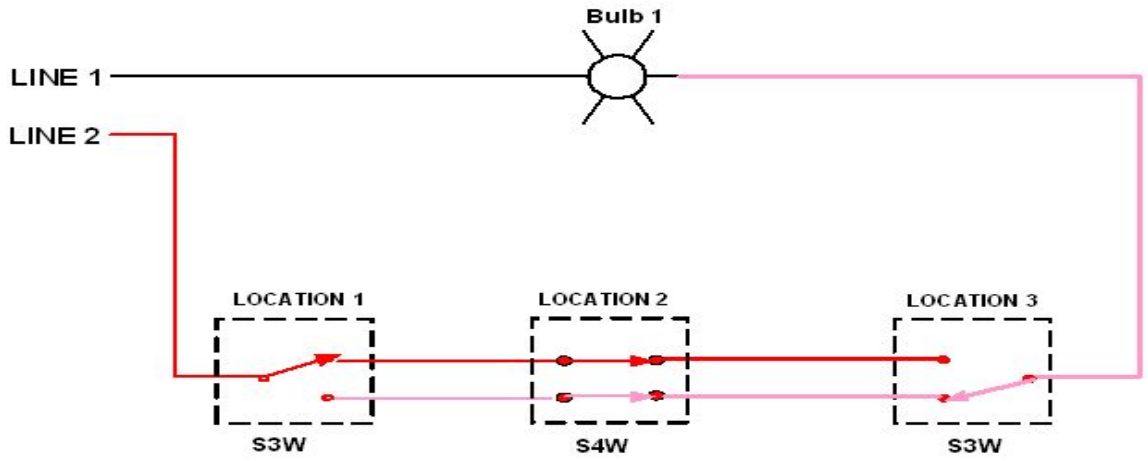


Fig 1.5

Self-check: 4	**Written test**

Name …… Date……

<u>Direction</u> I true or false

1. The phase line should be connect with switch before lamp
2. Lamp is connect next to switch
3. Two way switch is used to control a lamp from two position.
4. Single way switch is used to control lamp more than two position.

Information Sheet 5	Installing Wiring system

5.1 Introduction

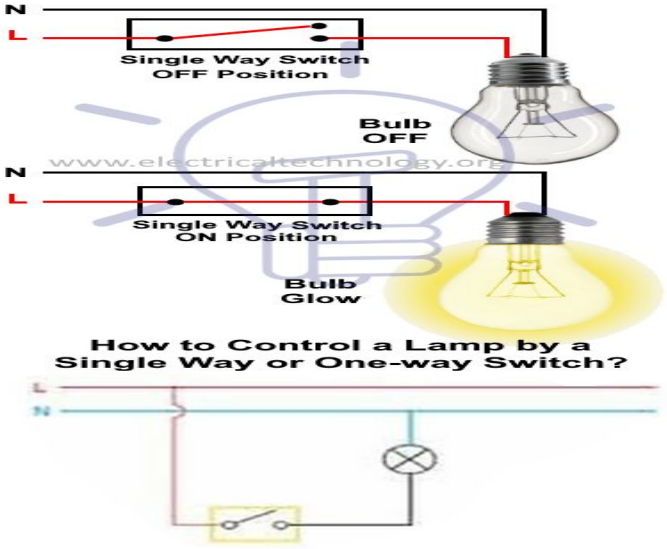
5.1.1Select materials from drawings The main diagram the electrician will work to is the scaled layout drawing, often called a plan. From this the electrician can count up the amount of accessories and items of equipment needed for the job. Cable lengths can also be calculated using the scale and likely cable routes shown on the drawing.

5.1.2 Marking out before starting actual installation work, the job has to be marked out. The drawing is used to show where all accessories and items of electrical equipment are to be fitted. It is important to install all equipment in the correct position. If a socket or switch is not placed where it should be it could end up hidden behind a cupboard or radiator. When marking out, the position of accessories, equipment and cable drops are drawn on to the wall with a pencil or chalk.

5.2 Single way switch

Below is a simple step by step tutorial with schematic and wiring diagram which shows how to wire a light switch to control the bulb/lamp from single place with the help of one way or single way switch?
Requirements:
Single Way Switch (SPST = Single Pole Single Through) x 1 No
Lamp (Light Bulb) x 1 No
Short pieces of cables x 3 No

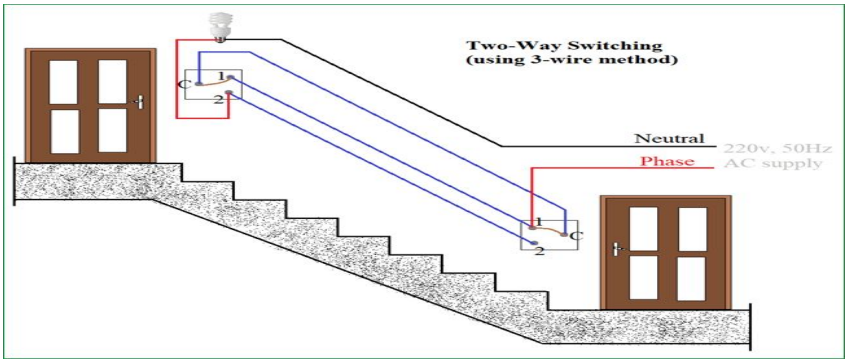
This is just like a series circuit i.e. all the components are connected in series. Just connect the Neutral wire directly to the light bulb and then connect the light bulb to the switch through middle wire. And then connect the live wire to the switch as shown in fig below. Fig given below shows the basic connection of light switch and their position i.e. when the switch is OFF, the circuit acts like an open circuit and the bulb won't glow. To switch on the bulb, switch S1 must be closed to complete the circuit and glow the light bulb.



Also note that home wire colors may vary according to different areas. In addition, always use and connect the earth wire (direct naked wire to switches, and electrical appliances from earth link in the distribution board to reduce the risk of electric shock and hazard) which is not shown in the figures above.

5.3 Two way light switch

In installing, we will show you how to make 2-way switching connection. A 2-way switching connection means you can control an electrical equipment like bulb by two switches placed at different places, generally used in the staircase. Two way switch can be operated from any of the switch independently, means whatever be the position of other switch(ON/OFF), you can control the light with other switch.

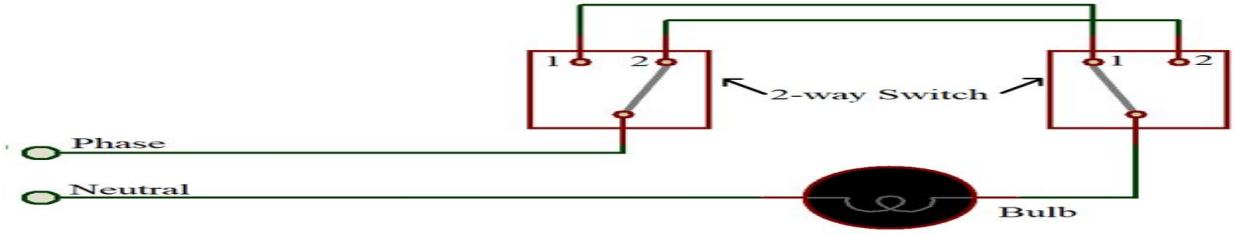


Required Components

Two 2-way switches, Bulb, AC supply, **c**onnecting wire

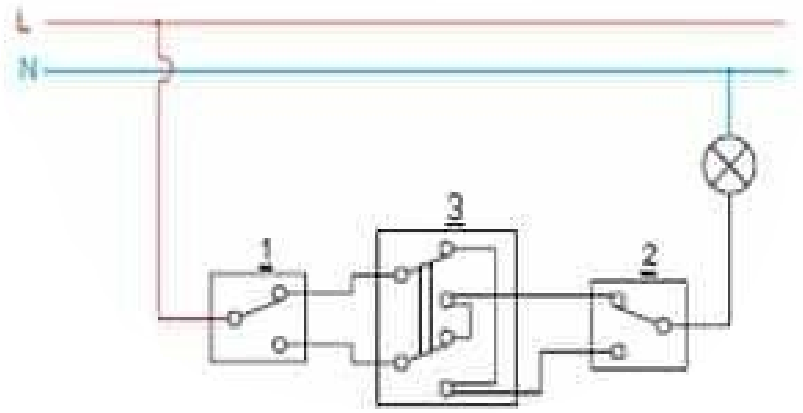
As you see in the Schematic Diagram of 2 way switch circuit below, you will find that the phase/live is connected with the common of the first 2-way switch. PIN1 & PIN2 of the first switch is connected with the PIN1 & PIN2 of second switch respectively. One end of the bulb is connected with the Common Terminal of second switch and other end of the Bulb is connected with Neutral line of AC power supply.

Note: In 2-wire control method when switches are in opposite state the light will be inn OFF state as shown in circuit below:



5.4 Controlling a light with three or more switches

For more than two switches, one or more 4-way switches are added between the 3-way switches. A 4-way switch has two positions. In the first position, the contacts are connected straight through, so that the switch has no effect. In position two, the switch cross connects the contacts on the left with the contacts on the right, in an "X" connection.



Self-check: 5	Written test

Name …… Date……

Matching

Direction Match the following <A> column with the given <B> column

A		B
1.	Single way switch	A. operated from any of the switch independently
2.	Two way switch	B. over current protective device
3.	Intermediate switch	C. Single Pole Single Through
4.	Circuit breaker	D. output device
5.	Lamp	E. have two input and two output terminal

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information Sheet 6	Responding Unplanned events or conditions

6.1 Responding unplanned events or conditions

It is essential that the unconditioned events observed in the following aspects:

- demonstrate knowledge of the Entertainment and Events Technology equipment and associated disconnection, storage and cleaning requirements
- determine work requirements and plan and organize work to fulfill such requirements
- identify, select and use tools, equipment and material to complete tasks to specifications
- disconnect equipment and cables safely and in accordance with specifications
- handle material and equipment safely
- identify and report problems promptly and handle them as directed
- prepare equipment and storage site
- complete cleaning and storage related tasks in accordance with health and safety procedures
- Perform inspection and quality checks - interpret and apply technical information to work activities
- demonstrate compliance with Occupational Health and Safety regulations applicable to workplace operations

- show compliance with organizational quality procedures and processes within the context of disconnecting, cleaning and storing Entertainment and Events Technology equipment
- Interactively communicate with others to ensure safe and effective operations

Self-check: 6	**Written test**

Name …… Date…….

Say true if the sentence is correct and say false if the statement is incorrect

1. Interactively communicate with others to ensure safe and effective operations is available if unplanned condition is happen
2. Perform inspection is available to responding unplanned events.

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

Information Sheet 7	Approving procedure and requirement of termination

7.1 How to Create an Approval Process and Workflow

In any organization, work often needs to be formally approved before it can begin. Budgets, creative projects, marketing initiatives, invoices, and many other work items all move through a series of approvals before they are considered either ready for kickoff or complete. Many organizations create specific approval processes or workflows that dictate how work should be approved (or rejected) every time to save time and ensure standardization.

7.2 What Is an Approval Process?

An approval process is the method an organization uses to approve anything from documents, invoices, budgets, and purchase orders, to a new process that a company wants to institute. Implementing an approval process can standardize an organization's internal processes, and also save time by creating a dependable, repeatable system. Approval processes are a type of workflow, which is any sequence of work from initiation to completion, that you can create to ensure work is approved the same way every time.

Creating an approval process can simply mean defining the procedures that you will follow to approve work.

7.3 Elements of an Approval Process

While each approval process will differ based on its purpose or the organization's specific requirements, there are some general tasks that you will likely include when designing your own. These include:

- **Submission**: An approval process usually begins with someone submitting something. You'll need to create a submission portal where users go to submit their work.
- **Assign Approvers:** you'll need to identify the person or people who have the final say. If your process has multiple approval levels, define who will approve which aspects of work at each level.
- **Set Permission Levels**: Define the level of authority each user should have. Most systems have features to delineate among viewer, editor, and administrator permissions, so you can control who edits, rejects, or approves submissions.
- **Set Due Dates:** As with any project, it's important to set deadlines to keep your workflows moving and prevent work backlogs.
- **Record/Log:** Having a record of every step in the approval process is one of its greatest benefits for increasing transparency and ensuring consistency. If you plan on using an automated solution, look for a program that offers the following capabilities:
- **View User History:** See who has made changes, to what, and when.
- **Lock Record:** This will make the record uneditable, so that no user can change the log of actions.
- **Edit Record:** In some cases, you might want the record to be kept editable - for instance, if you made a mistake or need to keep certain information private from other parties. While we're on the topic of automated workflows, it's important to note that some programs also offer additional functionality that can create a more customized feel, or help disrupt some of the inflexibility that can come with automation. Some of these functions include:
- **Task Lists:** It can be helpful to build task assignment into the approval process, allowing each employee to clearly see their responsibilities, and informing management of resource allocation. Many of these elements will be present in the approval process you design, regardless of the specific project or type or organization. In the next section, we'll discuss the software programs that allow you to build approval processes and workflows, and additional features to consider.

Self-check: 7	Written test

Name …… Date……

Say true if the sentence is correct and say false if the statement is incorrect

1. Approval processes are a type of workflow, which is any sequence of work from initiation to completion, that you can create to ensure work is approved.
2. Record/Log means an approval process usually begins with someone submitting something.
3. In any organization, work often needs to be formally approved before it can begin.

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

Operation Sheet 1	**Install electrical installation work**

2.5 Installing wiring system

Step 1 wear PPE

Step 2 Read and interpret the layout diagram

Step 3 Convert the given layout diagram into wiring diagram

Step 4 Select material, tools and instruments

Step 5 identify proper current ratings of conductor wire

Step 6 Installing electrical installation work

Step 7 Check all terminals for proper connections.

Step 8 Check the functionality of materials also check burned-out lamp and circuit breaker

Step 9 Check all enclosures for loose wires, tools and components.

Step 10 Check all wires terminated for being free of unintentional earth connections.

Step 11 Check for proper sequence of connections as per wiring diagram diagram.

Step 12 Check for proper sealing of conduit connections, cables.

Step 13 Finaly give the powe to the system.

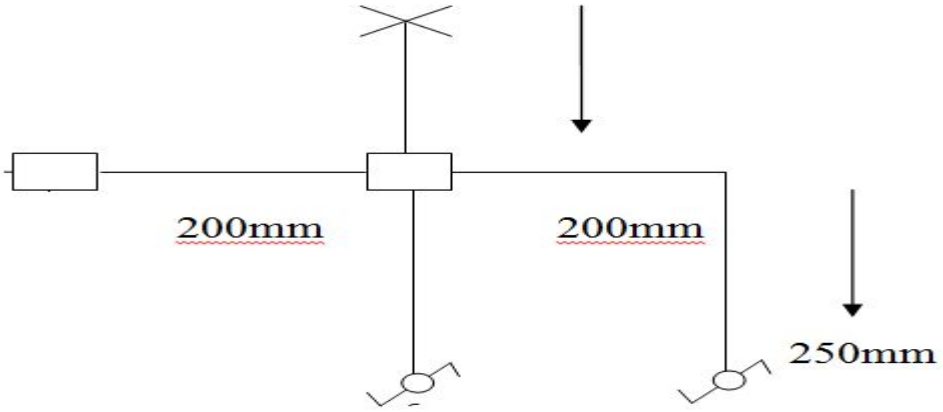
Operation Sheet 2	**Install electrical installation work**

2.5 Installing wiring system

Step 1 wear PPE

Step 2 Read and interpret the layout diagram

Step 3 Convert the given layout diagram into wiring diagram



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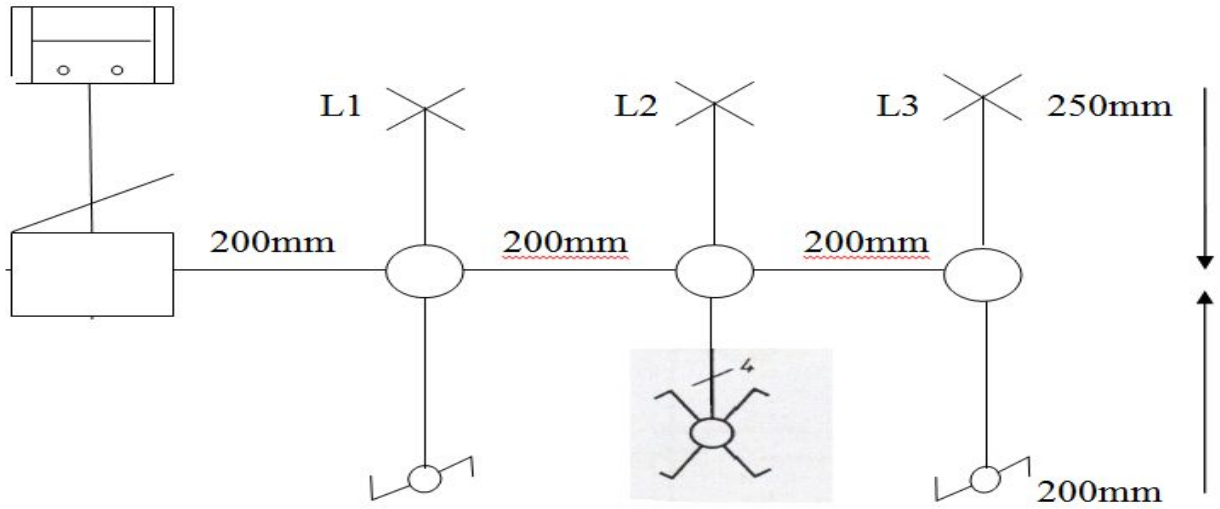
Operation Sheet 3	**Install electrical installation work**

2.5 Installing wiring system

Step 1 wear PPE

Step 2 Read and interpret the layout diagram

Step 3 Convert the given layout diagram into wiring diagram



Step 4 Select material, tools and instruments

Step 5 identify proper current ratings of conductor wire

Step 6 Installing electrical installation work

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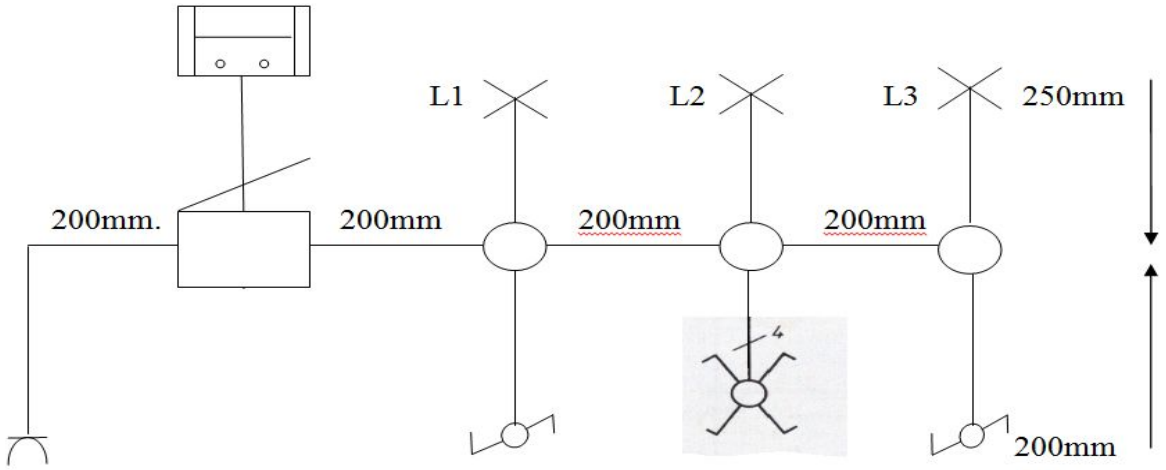
Operation Sheet 3	Installing wiring system

2.5 Installing wiring system

Step 1 wear PPE

Step 2 Read and interpret the layout diagram

Step 3 Convert the given layout diagram into wiring diagram



Step 4 Select material, tools and instruments

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Step 10 Check all wires terminated for being free of unintentional earth connections.

Step 11 Check for proper sequence of connections as per wiring diagram diagram.

Step 12 Check for proper sealing of conduit connections, cables.

Step 13 Finaly give the powe to the system.

- By using the above procedure do the following LAP test

LAP Test	Practical demonstration

Name …….. Date…….

Time started…….. Time finished……...

Instructions: given necessary templates , tools and materials you are required to perform the following tasks with 8 hours.

Task 1: Installing wiring system

Reference

Book

- **Ethiopian Building code standards electrical installation of building**

Internet

- https://www.smartsheet.com/approval-process-workflow
- http://ocw.ump.edu.my/pluginfile.php/11228/mod_resource/content/1/ST%20Guidelines%20For%20Electrical%20Wiring.pdf