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कौशल भारत-कुशल भारत

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MINISTRY OF SKILL DEVELOPMENT
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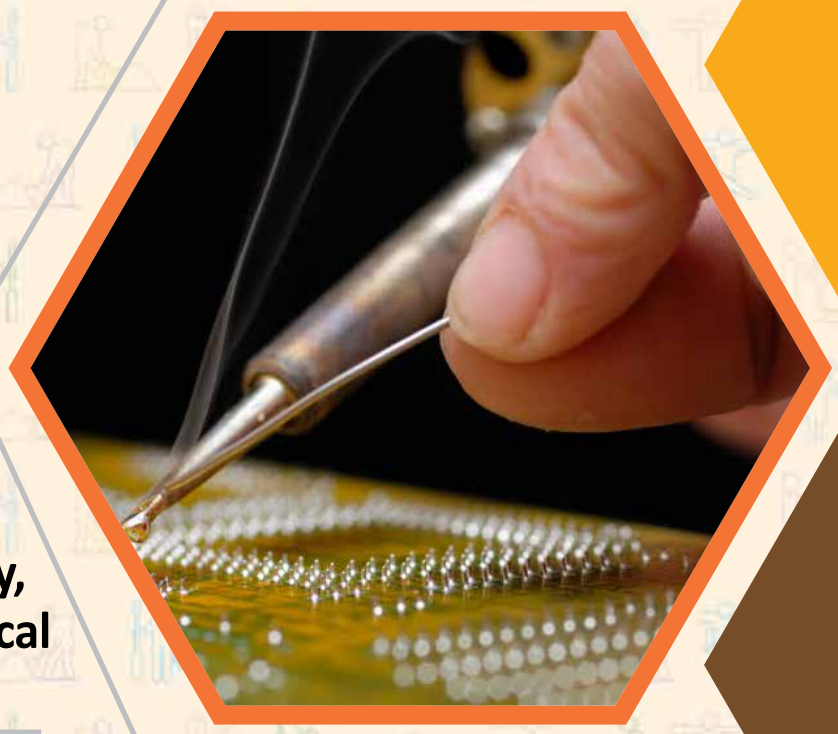
CAPITAL GOODS SKILL COUNCIL

Participant Handbook



Sector
Capital Goods

Sub-Sector
Machine Tools, Plastics Manufacturing Machinery, Textile Manufacturing Machinery, Process Plant Machinery, Electrical and Power Machinery

Occupation:**Fitting and Assembly**

Reference ID: **CSC/ Q 0305, Version 1.0**
NSQF Level 3

Fitter – Electrical and Electronic Assembly

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"Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission."

Shri Narendra Modi
Prime Minister of India

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Certificate

COMPLIANCE TO
QUALIFICATION PACK – NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the

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for

SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of
Job Role/ Qualification Pack: **'Fitter Electrical & Electronic Assembly'** QP No. **' CSC/Q0305 NSQF Level 3 '**

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Authorised Signatory
Capital Goods Skill Council

Acknowledgements

Capital Goods Skill Council would like to thank Capital Goods member company representatives for believing in our vision to enhance the employability of the aspiring workforce pool. CGSC facilitates this by developing and enabling the implementation of courses relevant to projected industry needs.

The aim is to address two key requirements, of closing the industry-academia skill gap, and of creating a talent pool that can reasonably meet current competitiveness requirements and weather future externalities in the Capital Goods Sector providing impetus to the Make in India program.

CGSC believes that this is an initiative of great importance for all stakeholders concerned – the industry, academia, and the aspirants. The tremendous amount of work and ceaseless support offered by the members of CGSC in developing a meaningful strategy for the content and design of program training materials has been truly commendable.

we would like to thank all concern stakehplders who have help us in bringing much needed focus to this effort.

Inder Gahlaut

CEO

CGSC

About this book

This Participant Handbook is designed to enable training for the specific Qualification Pack (QP) of Capital Goods Industry. Each National Occupational (NOS) is covered across the Units. MIG/MAG/ Fitter – Electrical and electronic assembly assemble and wire up electrical panels/components and electronic equipment and systems to mechanical equipment.

It involves the assembly of the electrical panels,equipment/systems and electronic products, inclusive of components, sub-assemblies, or completed equipment/systems. Along with soldering techniques and anti-static protection techniques assemble with the mechanical equipment.

Key Learning Objectives for the specific NOS mark the beginning of the Units for that NOS. The symbols used in this book are described below.

Symbols Used


Key Learning Outcomes


Steps


Exercise


Tips


Notes


Unit Objectives

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1. About Capital Goods Industry

Unit 1.1 - Understanding of capital goods industry

Unit 1.2 - Understanding various types of capital goods Industry

Unit 1.3 – Role of electrical and electronic fitter in industry

Key Learning Outcomes

At the end of this module, you will be able to:

1. Discuss about capital goods industry
2. Discuss about development activities in industry
3. Discuss about employment opportunities in India
4. Explain about industry structure
5. List job responsibilities of a fitter

Unit 1.1: Understanding of Capital Goods Industry

Unit Objectives

At the end of this unit, you will be able to:

1. Discuss about industry
2. Understand development activities in the industry
3. Know about manpower requirements in industry

1.1.1 Introduction

Capital Goods are used in producing other products but are not incorporated into the new product. Capital Goods industry involves plant and machinery, equipment / accessories required for manufacture / production, either directly or indirectly, of goods or for rendering services, including those required for replacement, modernization, technological up gradation and expansion. It also includes packaging machinery and equipment, refrigeration equipment, power generating sets, equipment and instruments for testing, research and development, quality and pollution control. The Capital Goods industry is the “mother” of all manufacturing industry. The capital goods industry contributes 1.8% to the GDP which is 12% of the total manufacturing sector. For achieving goal of 9% growth in GDP during the 12th Five Year Plan, it is essential for the manufacturing industry to grow at least by 11-13% per annum. The Capital Goods sector, which plays vital role in manufacturing sector, should grow at around 17-19%.

Fig. 1.1.1 Capital Goods

1.1.2 Development activities in the industry

Sectors such as engineering, construction, infrastructure, and consumer goods play a strong base for Indian Capital industry. It can be further divided into ten broad sub-sectors namely heavy electrical equipment; Food Processing machinery; Printing Machinery; process plant equipment; earth moving equipment; dies, moulds and tool textile machinery; machine tools; metallurgical machinery and plastic processing machinery. It generates not only employment but also supports national security and hence boost to economy. 1.4 million people and is estimated to employ 2.8 million by 2017. The industry contributes 12% to the total manufacturing output of India and around 1.8% to the national GDP. The total market size of the industry around $92 billion and production valued at $32 billion. Instead of core industries such as power, railway, Infrastructure, etc, capital goods sector is growing year after year. There is a lack of domestic and global demand so this sector is currently facing insufficient off-take but it does not mean it has no potential. It is believed that it can boost the sector to approximately Rs. 7 lakh crore over next 4-5 years.

Fig. 1.1.2 Capital Goods Workshop

Increasing demand leads to the growth of the Capital Goods sector in India, and sectoral production has increased 2.5 times in 2013-15 as compared to 2004-05.

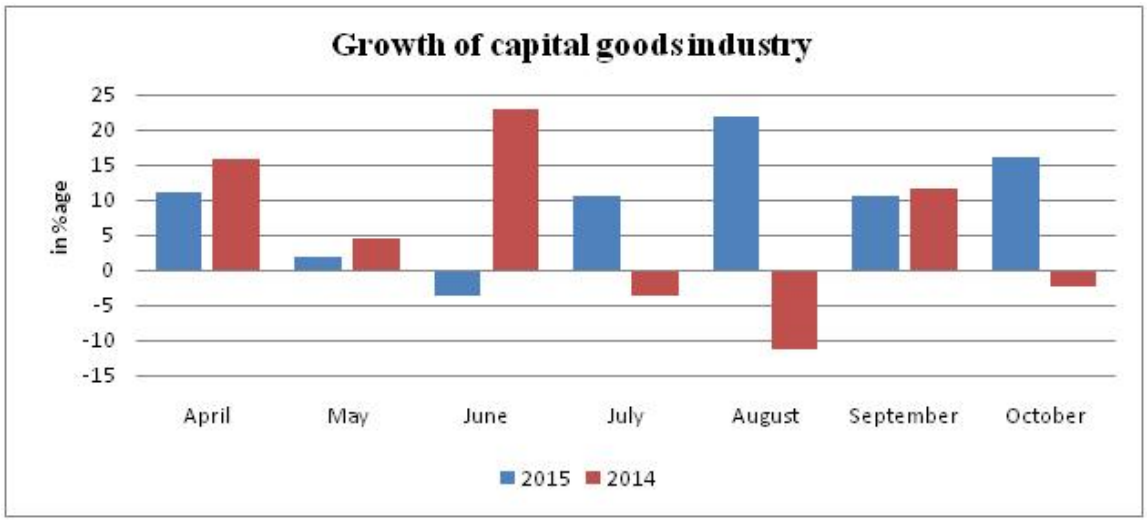

Fig. 1.1.3 Growth of Capital Goods Industry

1.1.3 Government policy of capital goods industry

There are some objectives of draft of a national capital goods policy:

- Increase total production: To achieve total production in excess of Rs. 50,000 crore by 2025 from the current Rs. 220,000 crore, there should be a friendly ecosystem for a globally competitive capital goods sector.
- Increase employment: To increase domestic employment from the current 1.4 million to at least 5 million by 2025 thus providing additional employment to over 3.5 million people.
- Increase domestic market share: It also envisages increasing the share of domestic production in capital's goods market from 56% to 80% by 2025 and for this improves domestic capacity utilization to 80-90%.
- Increase exports: To increase exports to 40% of total production (from Rs 62,000 crore to Rs 200,000 crore) by 2025, enabling India's share of global exports in capital goods to increase to 2.5%.
- Improve skill availability: To achieve higher productivity in the capital goods sector with enhance availability of skilled manpower by training 50 lakh people by 2025, and establish institutions to deliver the human resources with the skills, knowledge and capabilities to boost growth and profitability.
- Improve technology depth: To improve 'technology depth' in capital goods sub-sectors by increasing research intensity in India from 0.9% to at least 2.8% of GDP to rank amongst the Top-10 countries in research intensity and achieve global benchmarks for intellectual property in the capital goods sector.
- Promote standards: Technical and safety measure are up to the international standards and to achieve this, inflow of sub-standard capital goods need to be curb.
- Promote SMEs: To compete with established domestic and international firms and become national and global champions of capital goods in the future, growth and capacity of SMEs sector need to be increased.

1.1.4 Spread of capital goods industry in India

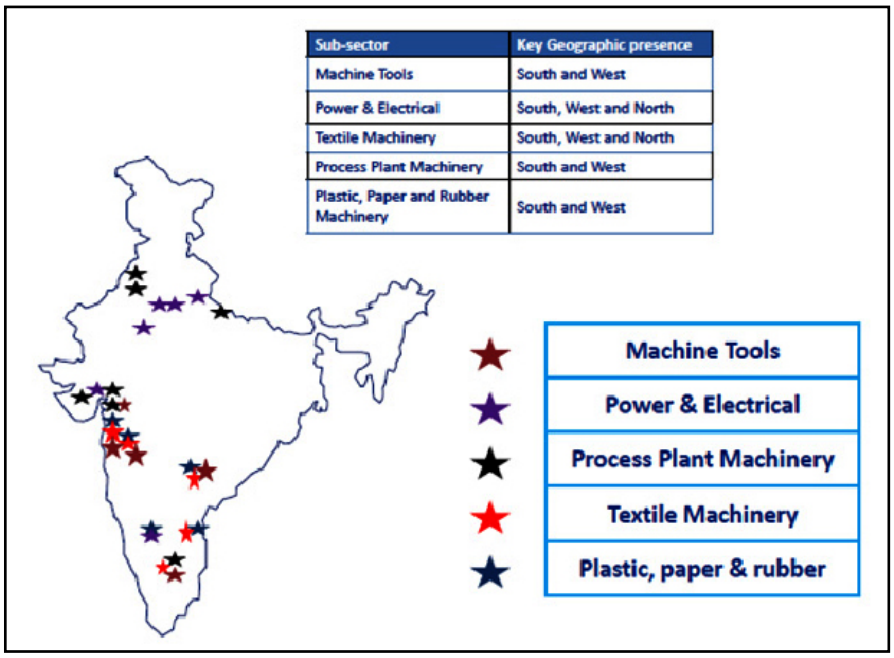

Fig. 1.1.4 Spread of capital goods industry in India

1.1.5 Manpower requirement in the industry

KPMG supported by NSDC, FICCI and CGSC study on Human Resource and Skills Requirement in the field of Capital Goods Sector and assign manpower requirement in 2017 across the six sub-sectors is approximately 2,085,000. The distribution of the same across subsectors and functions are as follows:

Manpower requirement in 2017							
Function	Machine Tools	Power & Electrical	Process Plant Machinery	Textile Machinery	Plastic, Paper & Rubber Machinery	Light Engineering Goods	Total
Production	237,200	679,000	227,500	1,313,000	90,700	573,300	1,939,400
Support Functions	17,900	51,100	17,100	9,900	6,800	43,100	146,000
	255,000	730,100	244,600	141,700	97,500	616,400	2,085,400

Table 1.1.1 Manpower requirement in 2017

The study projects the manpower requirement in 2022 across the six sub-sectors is approximately 3,940,800. The distribution of the same across subsectors and functions are as follows:

Manpower requirement in 2022							
Function	Machine Tools	Power & Electric-als	Process Plant Ma-chinery	Textile Ma-chinery	Plastic, Paper & Rubber Ma-chinery	Light En-gineering Goods	Total
Produc-tion	477,500	1,240,000	385,400	226,300	215,600	11,203,000	3,665,100
Support Functions	35,900	93,300	29,000	17,000	16,200	843,000	275,700
Total	513,400	1,333,300	414,400	243,300	231,800	1,204,600	3,940,800

Table 1.1.2 Manpower requirement in 2022

Notes

Unit 1.2: Understanding structure of Capital Goods Industry

Unit Objectives

At the end of this unit, you will be able to:

1. Discuss about capital goods industry structure
2. Know about features of industry

1.2.1 Capital goods sub-sectors

On the basis of end-usage, the sector is normally divided into 8-10 major sub-sectors. The main sub-sectors thus identified as sub-sectors of the capital goods sector are:

S. No	Sub Sectors	Brief Description
1	Machine Tools	Constitutes machines related to metal cutting and forming
2	Power & Electrical equipment	Constitutes machines related to power generation, transmission and distribution
3	Process Plant Machinery	Constitutes machines such as pressure vessels, evaporators, stirrers, heat exchangers etc. are used in energy, metallurgy, oil and gas, industry etc.
4	Textile Machinery	Constitutes machines used in various steps of textile fabrication such as spinning weaving, processing, testing etc.
5	Plastic, Paper & Rubber Machinery	Constitutes machinery used in various fabrication steps of paper, plastic and rubber manufacturing
6	Light Engineering Goods	Constitutes machines related to roller bearing, process control, instruments, castings, steel forgings, and pipes etc used in oil & gas, power, automotive etc. industries
7	Earthmoving, Construction and Mining Equipment	Constitutes machines such as graders, dozers, excavators etc for mining and mixers, tippers, road millers etc. For constructions.
8	Material Handling and Lifting Equipment	Constitutes primarily of forklifts and cranes.
9	Agricultural Machinery	Constitutes machines used in various steps of agriculture such as land development, sowing weeding, harvesting etc.

Table 1.2.1 Sub Sectors of Capital Goods Industry

1.2.2 Features of capital goods industry

- Economic performance of the sector is linked with that of manufacturing industry which is the key end-user of the Capital Goods industry.

Fig. 1.2.1 Economic performance of the Industry

- Capability to manufacture most of the major capital goods limited to domestic purpose. However, imported machineries from foreign give a stiff competition because of better technology and competitive pricing.
- The output of the sector is concentrated with a top few companies in most product groups, followed by a section of companies comprising medium to small scale players.
- Indian companies primarily target on the domestic market leaving export market intact. However, some of the larger players are exploring export market growth targeted especially towards the Middle East and Asian markets. The sector is expected to depend on government support on areas like export financing and promotion to tap vast global capital goods market opportunity.

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4. Basic introduction of electricity

Unit 4.1 – Electricity fundamentals

Unit 4.2 – Electric circuits

Unit 4.3 – Electrical wiring

Unit 4.4 – Tools and measuring instruments required

CSC/N0305

Key Learning Outcomes

At the end of this module, you will be able to:

1. Discuss about basic electric fundamentals
2. Discuss about how electricity generate
3. Discuss about different sources of electricity generation
4. Know about how current flow in the circuit
5. Know about ohm's law
6. Know about electrical circuit
7. Know about different types of electric circuit
8. Know about electrical wiring diagram
9. Discuss about how to secure electrical wiring
10. Know about different tools and measuring instruments required
11. Know about how to calibrate measuring instruments

Unit 4.1: Electricity fundamentals

Unit Objectives

At the end of this unit, you will be able to:

1. Understanding of electricity and how electricity generate
2. Understanding of conductors, insulators and semiconductors
3. Understanding of how a conductor, conducts electricity
4. Know about different sources of electricity

4.1.1 Electric Fundamentals

The most important system today is the electrical system. Electricity is used by more and more components and systems every year.

- It cannot be visible.
- Output of power can be noticeable.
- Spotting and calculation of electricity is must.
- The test outcomes must be elucidated.

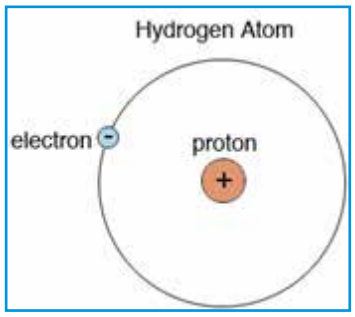


Fig 4.1.1 Nucleus

Electricity

Transition of electrons from one particle to another is called electricity. Nucleus is defined by the dense centre of each atom.

The nucleus covers:

- Protons , have positive charge
- Neutrons , with no electrical charge

Around the nucleus electrons are moving in orbits and carries negative charge. Number of electrons and protons are equal in each atom. Sort of material and conduction of electricity can be determined by the no. electrons and protons in the atom. An atom has neutral charge because an atom consist equal no. of negative-charged electrons and positive-charged protons in it.

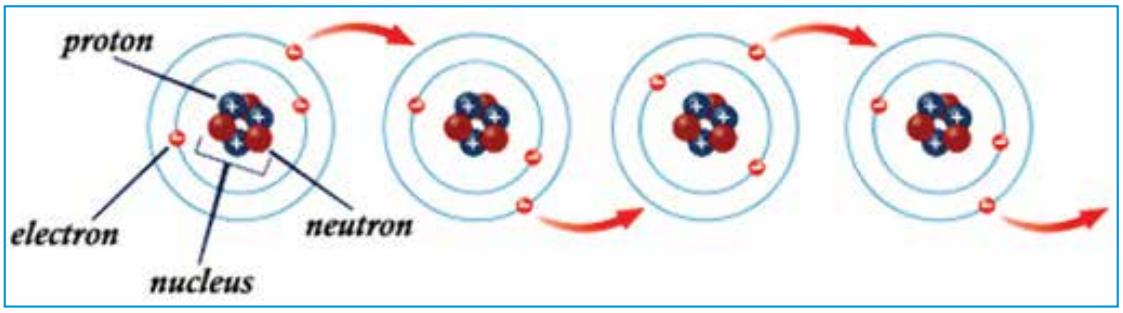


Fig 4.1.2 Movement of atoms in nucleus

4.1.2 Conductors, semiconductors and insulators

Conductors: The materials that allow the flow of electrical current in one or more directions is known as conductor. A common electrical conductor is metal wire. Conductors which are commonly used:

- Silver
- Aluminium
- Gold
- Cast iron
- Steel

Fig 4.1.3 metal wire - Conductor

Insulators: It is a material whose interior electric charges doesn't flows easily, and therefore make it almost impossible to conduct an electric current under the influence of an electric field. Following are the examples of insulators:

- Rubber
- Nylon
- Plastic
- Porcelain
- Fibreglass
- Ceramic

Fig 4.1.4 Insulation wire

Semiconductors: These are hard chemical element or

compound which can conduct electricity under some specific situations, this characteristic makes it a nice source for the control of electrical current.

Examples of semiconductors:

- Silicon
- Carbon
- Germanium

Mostly use of semiconductors is in transistors, computers, and other electronic devices

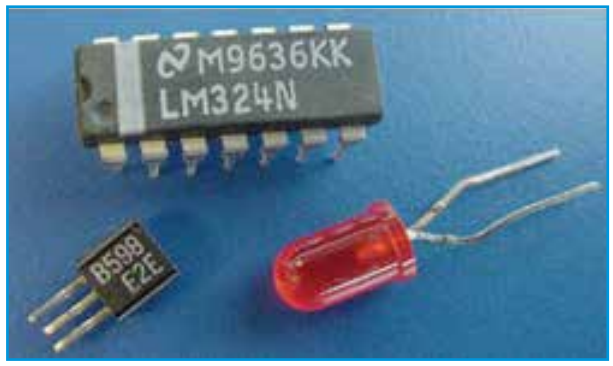


Fig 4.1.5 semiconductors

4.1.3 How Electrons Move Through a Conductor

Current flow

- A flow of electric charge is known as an electric current. This charge is often carried by moving electrons in a wire in electric circuits.
- Ampere is the SI unit for calculating an electric current.

Location of a positive charge (lack of electrons) is on one conductor end and location of a negative charge (overload of electrons) is on the opposite conductor end, this happens when conductors ends are joined with the source of power (battery). For the flow of current, disproportion of surplus electrons at one side of the circuit and absence of electrons at the opposite side of the circuit is required.

- The negative charge repels free electrons from the atoms of the conductor, whereas electrons will be attracted by positive charge on the opposite side of conductor.
- Due to this magnetism of opposite charges and dislike of like charges, electrons will circulate through the conductor.

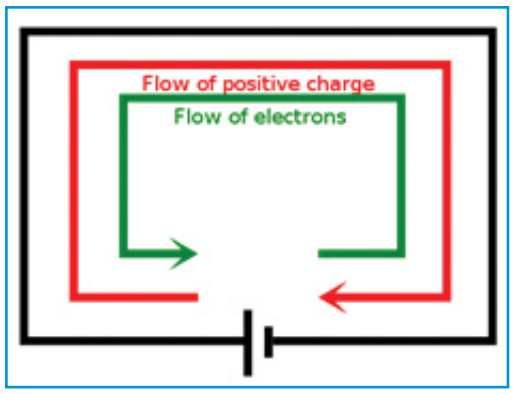


Fig 4.1.6 flow of electrons in a conductor

4.1.4 Sources of Electricity

1. **Friction:** When different materials are rubbed together, the friction generates and causes electrons to be transformed from one to the other. Now both materials are in electrically charged state. These charges are not in motion, they deposited on the surface.
2. **Heat:** Thermoelectricity is defined as when pieces of two dissimilar metals are connected together at both ends and one junction is heated then the current permits through the metals.

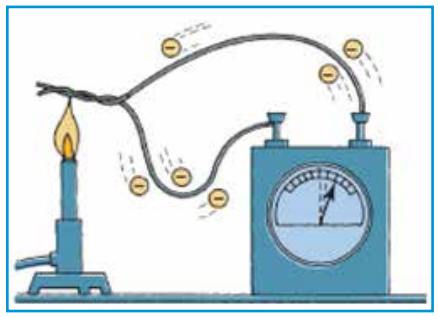


Fig 4.1.7 generation of electricity by heat

3. **Light:** The light energy is shifted to the free electrons of the metal when certain metals are exposed to light. This extra energy breaks the electrons free from the surface of the metal. Electrons can then be together and prepared to move in a conductor. Light-measuring devices such as automatic headlamp dimmers and photographic exposure meters used by this photo-electricity.

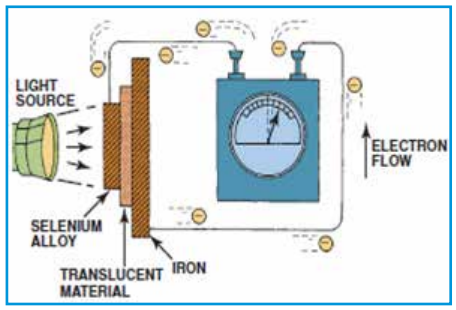


Fig 4.1.8 generation of electricity by light

4. **Chemical:** A change is produced in potential or voltage when two dissimilar materials (usually metals) placed in a conducting and reactive chemical solution. It is the basis of the automotive battery and this principle is called electrochemistry.
5. **Magnetism:** If a conductor is moved through a moving magnetic field or a magnetic field near a conductor, electricity is created. This is the principle of how many automotive devices work, including:
   - Starter motor
   - Alternator
   - Ignition coils
   - Solenoids and relays

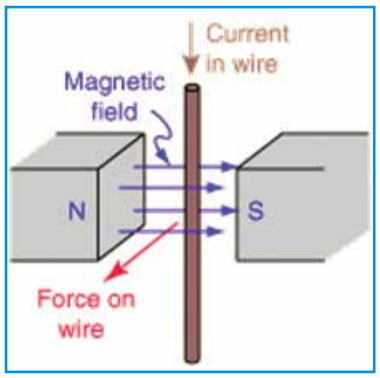


Fig 4.1.9 Magnetism

Notes

Unit 4.2: Electrical Circuits and Ohm's Law

Unit Objectives

At the end of this unit, you will be able to:

1. Understanding of electrical circuits and parts of a circuit
2. Understanding of Ohm's law
3. Understanding of different types of electrical circuit

4.2.1 Circuits

A circuit is a complete path in which electrons travel from a power source (like battery) through a load like light bulb and then return back to the power source.

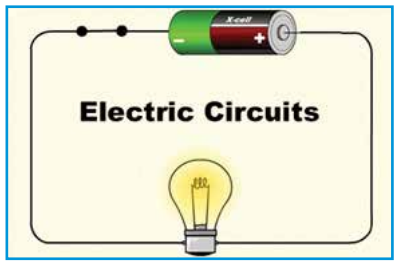


Fig 4.2.1 simple electric circuit

4.2.1.1 Parts of a complete circuit

A complete circuit contains following components:

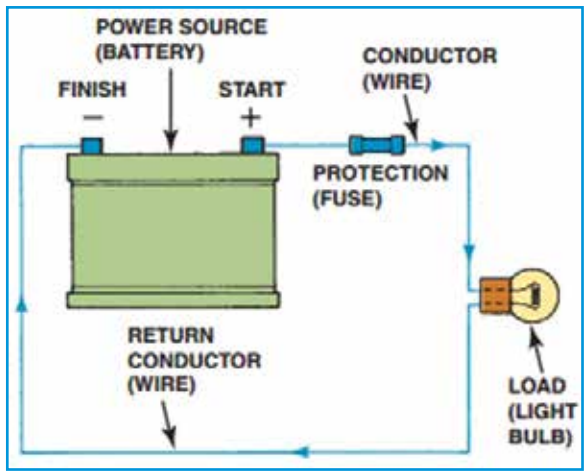


Fig 4.2.2 electric circuit

- A battery is used as a power source
- Electrical circuit protection devices like fuses, circuit breakers, and fusible links are used for the protection from harmful overloads (excessive current flow).
- The flow of current from the power source to the resistance is defined as the power path.
- The electrical load or resistance which changes electrical energy into heat, motion, or light.
- The electrical current from the load back to the power source.
- Switches are used to turn the circuit on and off.

4.2.1.2 Circuit Fault Types

Open circuits: It is a circuit that isn't complete, or lacks continuity, due to a damaged wire.

Following features are of open circuits:

- Through an open circuit no current will flow.
- If there is a break formed in the circuit, and then an open circuit may be created and saves the flow of current.
- The function of a fuse is to blow (open) when the current in the circuit surpasses the fuse rating. To stop any damage to the components or wiring as a outcome of the fault, the fuse will stops flow of current.

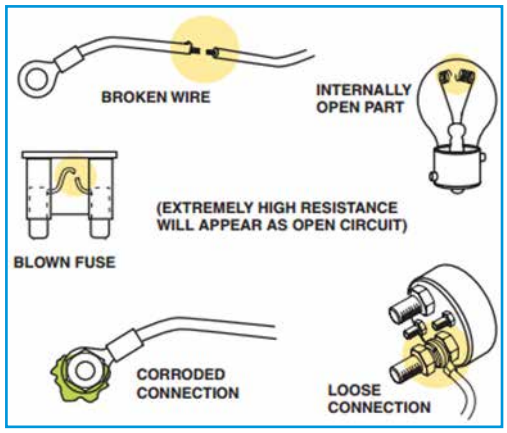


Fig 4.2.3 open circuits

Short-to-voltage: When the power side of one circuit is electrically joined to the power side of another circuit then a short-to-voltage occurs.

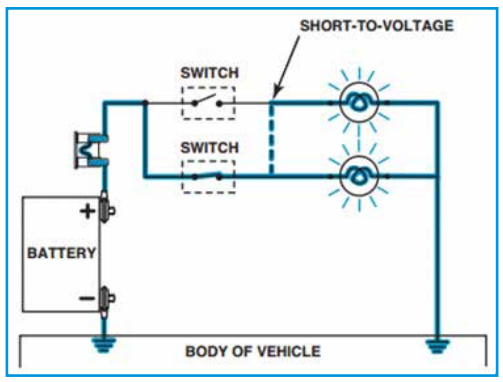


Fig 4.2.4 short circuits

Following are the features of short circuit:

- A complete circuit in which the current generally bypasses some or all of the resistance

in the circuit.

- The power side of the circuit is involved.
- A copper-to-copper connection (two power-side wires touching together) is involved.
- A fuse may or may not blow.

4.2.2 Ohm's Law

Ohm's law tell us that a current flowing in a close circuit has a direct relationship with the voltage given to that circuit and is inversely proportional to the resistance of that circuit, provided the

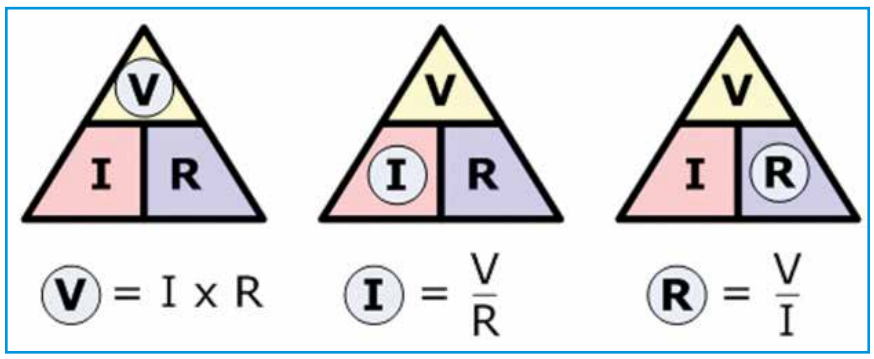


Fig 4.2.5 ohm's law

temperature and physical condition is constant.

If, for example, the current (I) is unknown but the voltage (E) and resistance (R) are known, then

Where,

I = Current in amperes (A)

E = Electromotive force (EMF) in volts (V)

R = Resistance in ohms (Ω)

VOLTAGE	RESISTANCE	AMPERAGE
Up	Down	Up
Up	Same	Up
Up	Up	Same
Same	Down	Up
Same	Same	Same
Same	Up	Down
Down	Up	Down
Down	Same	Down

Table 4.2.1 Ohm's law relationship with the three units of electricity

Ohm's law applied to simple circuits

As shown in the figure below for example, if a battery contains 12 volts is joined to a resistor of 4 ohms, how many amperes will travel through the circuit?

To analyse the number of amperes that will travel through the wires and the resistor by the use of Ohm's law. Remember, the factor (amperes) can be analysed by using Ohm's law if two factors are known.

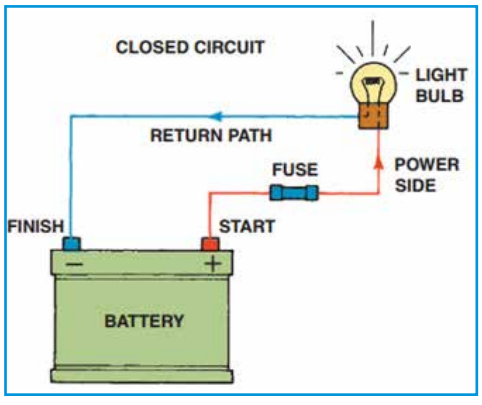


Fig 4.2.6 ohm's law circuit

$$I = \frac{E}{R} = \frac{12\,V}{4\,\Omega} A$$

Here (I) is 3 amperes if voltage (E) is 12 Volts and the resistance (R) 4 ohms.

4.2.3 Types of electric circuit

Series Circuit: A series circuit is a circuit that has multiple loads and a single path to go through. Such as a circuit that is connected with a battery and three light bulbs. First a current has to connect to one load, then the other, and finally it will flow through the last load and back to the battery. The current can be calculated with this

$$I = \frac{V}{R_1 + R_2 + R_3}$$

Parallel Circuit: Like the series circuit, the parallel circuit passes through more than one load. However, the circuit gives the current more than one path to complete the circuit with. Since it has multiple paths, the current will encounter less resistance by moving through all of the paths at the same time. The current in a parallel circuit depends on the different resistances, but a parallel circuit will create less resistance on a current. Using Ohm's law to calculate this, we would take the individual resistances of the loads and use their reciprocals, then add them and divide the voltage by it.

$$I=V\,(R_1+R_2+R_3)$$

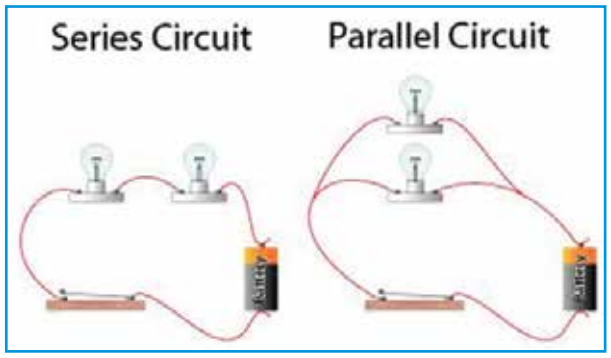


Fig 4.2.7 series circuit and parallel circuit

Series Parallel Circuit: The type of circuit is a combination of both series and parallel. Electric current travels through both circuits.

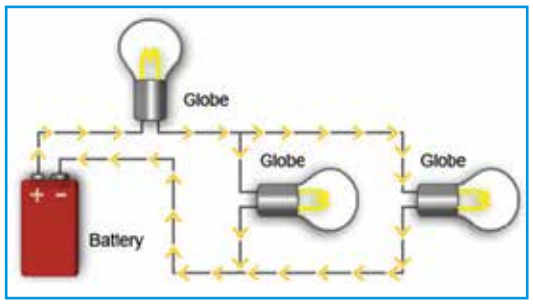


Fig 4.2.8 series-parallel circuit

Notes

Unit 4.3: Electrical Wiring

Unit Objectives

At the end of this unit, you will be able to:

1. Discuss about electrical wiring.
2. Discuss about various methods used for securing electronic wiring
3. Know about heat shrink sleeves, strapping, cable ties and p-clips
4. Know about wiring diagram

4.3.1 Electrical Wiring color Code

Electrical wires follow standard color coding that helps classify each wire function in the circuit.

In India wires are RGB mode i.e. Red- Green- Black. Each of these RGB wire have different functions.

- **Red –** Red wire signifies the phase in electric circuit. It is the live wire which cannot be connected to another red wire or black wire. Red is used in some types of switch leg. Switch leg is the wire that comes off from the bottom terminal of a switch and when the switch is turned on becomes hot. This is the leg that turns the load off and on.
- **Black –** Black wires signifies neutral wire in electric circuit. The neutral wires are connected to neutral bus bar inside an electric panel. A bus bar is and conductive metal bar that attracts the electric current for distribution purpose). Black wire can be connected to black wire only and no other color wire.
- **Green** – Green wire stands for grounding/ earthing in electric circuit. A green wire should be connected to green wire only (no other wire). Grounding wires are usually not meant for lights and fan purposes. Green wires are chiefly used for socket purpose.

Type of Wire	Colour
Neutral	Black
Earth	Green or Green and Yellow
Phase	Red or Yellow or Blue

Table 4.3.1 Wire color code

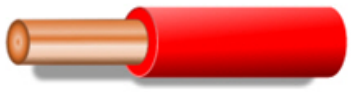
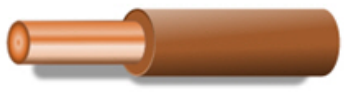
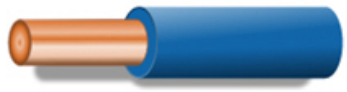
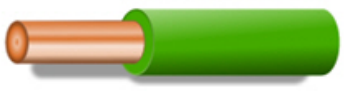
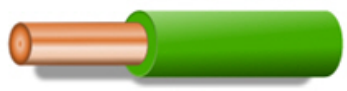
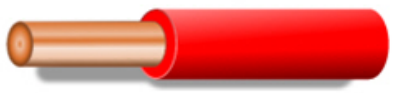
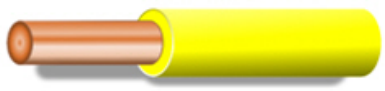
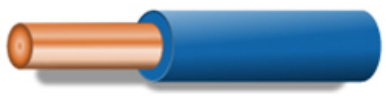
Function	*India Color Code (Old)*	*India Color Code (New)*
Single Phase Line		
Single Phase Neutral		
Single Phase Protective Ground or Earth		
Three Phase Line (L1)		
Three Phase Line (L2)		
Three Phase Line (L3)		
Three Phase Neutral (N)		
Three Phase Protective Earth or Ground (PE)		

Fig 4.3.1 Wire color code

4.3.2 Standard Cable and Wire Sizes

IEC 60228 is the International Electrotechnical Commission's international standard on conductors of insulated cables. Among other things, it defines a set of standard wire cross-sections:

International standard wire sizes (IEC 60228)					
0.5 mm^2	0.75 mm^2	1 mm^2	1.5 mm^2	2.5 mm^2	4 mm^2
6 mm^2	10 mm^2	16 mm^2	25 mm^2	35 mm^2	50 mm^2
70 mm^2	95 mm^2	120 mm^2	150 mm^2	185 mm^2	240 mm^2
300 mm^2	400 mm^2	500 mm^2	630 mm^2	800 mm^2	1000 mm^2

Table 4.3.2 International standard wire sizes (IEC 60228)

4.3.3 Securing electronic wiring

Heat shrink sleeves

Fig 4.3.2 Heat shrink sleeve

Heat shrink sleeve is a shrinkable plastic tube used to insulate wires, providing abrasion resistance and environmental protection for stranded and solid wire conductors, connections, joints and terminals in electrical work. It can also be used to repair the insulation on wires or to bundle them together, to protect wires or small parts from minor abrasion, and to create cable entry seals, offering environmental sealing protection. Heat shrink tubing is ordinarily made of nylon or polyolefin, which shrinks when heated.

Strapping

Fig 4.3.3 Cable strapping

Strapping, also known as bundling and banding, is the process of applying a strap to an item to combine, hold, reinforce, or fasten it. The strap may also be referred to as strapping.

Cable ties

A cable tie or tie-wrap, also known as a hose tie, or zip tie is a type of fastener, for holding items together, primarily electric cables or wires. Because of their low cost and ease of use, tie-wraps are ubiquitous, finding use in a wide range of other applications. Stainless steel versions, either naked or coated with a rugged plastic, cater for exterior applications and hazardous environments.

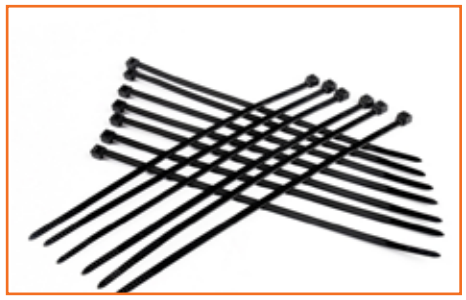


Fig 4.3.4 Cable ties

The common tie-wrap, normally made of nylon, has a flexible tape section with teeth that engage with a pawl in the head to form a ratchet so that as the free end of the tape section is pulled the tie-wrap tightens and does not come undone. Some ties include a tab that can be depressed to release the ratchet so that the tie can be loosened or removed, and possibly reused.

P-clips

Fig 4.3.5 P clips

- Preformed P clips will clamp wires or wire bundles of 16 to 50 mm diameter.
- P-clips offer good resistance to ageing, corrosion and ozone and UV radiation and have good dielectric properties.
- Ideal for use with electrical equipment and for interior/ exterior installation work.

4.3.4 Wiring diagram

A wiring diagram is a simplified conventional pictorial representation of an electrical circuit. This is the drawing which shows all the wiring between the parts, such as:

- control or signal functions;
- power supplies and earth connections;
- termination of unused leads, contacts;
- interconnection via terminal posts, blocks, plugs, sockets, lead-throughs.

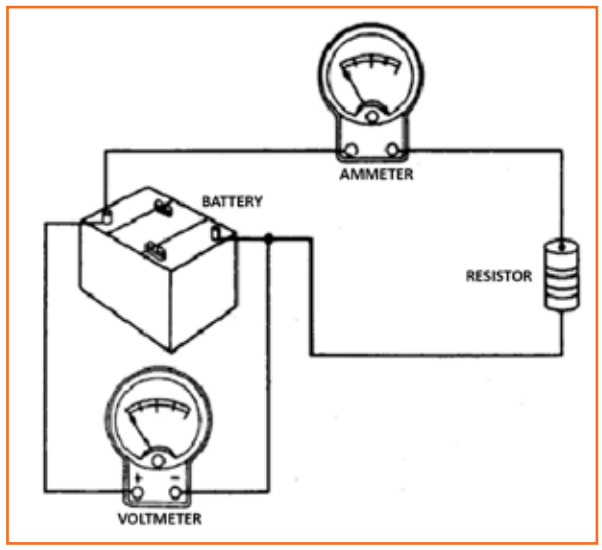


Fig 4.3.6 Wiring diagram

It will have details, such as the terminal identification numbers which enable us to wire the unit together. Parts of the wiring diagram may simply be shown as blocks with no indication as to the electrical components inside.

4.3.4.1 Reading wiring diagram

Whether you are working with a vehicle, appliance, or light fixture, knowing how to read a wiring diagram will help you prevent personal injury or damage to the object on which you are working. It will show you the electric circuits within the object so you can complete your project safely.

1. **Find the wiring diagram.** Wiring diagrams are often provided with appliances and other objects. See the wiring diagram for wiring instructions
2. **Check your voltage (V).** Check voltage requirements of the equipment as described in the wiring diagram.
3. **Learn the symbols.** Knowing what the symbols in your wiring diagram mean will help you find different electronic components and wiring connections with the mechanical equipment. Symbols usually resemble the part they represent.
4. **Know the color code.** Different color wires represent different components. This makes testing different components within the system easier. There should be a key or legend on the wiring diagram to tell you what each color means. The specific colors for a home electrical system are generally the same across all electrical items.

- White wires are neutral. They carry power back to the service panel.
- Green or bare wires are the ground wires. These carry power back to the service panel in case the neutral wires fail.
- Black, red, blue, and other colors represent hot wires. These are the ones that carry power to the object with which you are working.
- Use a voltage tester if you are unsure what the different colors mean.

4.3.5 Wiring schedule

This defines the wire reference number, type (size and number of conductors), length and the amount of insulation stripping required for soldering.

In complex equipment you may also find a table of interconnections which will give the starting and finishing reference points of each connection as well as other important information such as wire colour, indent marking and so on.

Schedule: Motor Control					
Wire No.	From	To	Type	Length	Strip Length
1	TB 1/1	CB 1/1	16/0.2	600 mm	12 mm
2	TB 1/2	CB 1/2	16/0.2	650 mm	12 mm
3	TB 1/3	CB 1/5	16/0.2	600 mm	12 mm
4	TB 1/4	MC /A1	16/0.2	800 mm	12 mm
5	TB 1/5	CH/1	16/0.2	500 mm	12 mm

Table 4.3.3 Wiring schedule

4.3.6 Wire run list

Wire Running LIst					
Wire No.	Termination From	To	Wire No.	Termination From	To
1	CB1 (-)	R6-1	5	CB5 (-)	CRE5 (+)
2	CB2 (-)	R2-1	6	CB6 (-)	CRE6 (+)
3	CB3 (-)	CRE3 (+)	7	CB7 (-)	CRE7 (+)
4	CB4 (-)	CRE4 (+)	8	CB8 (-)	CRE8 (+)

Table 4.3.4 Wire run list

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