Unit-II

Concept of Wires

Wire – It is a single, usually cylindrical, flexible strand or rod of metal. Wire are used to bear mechanical loads or electricity and telecommunication signals.

Wires is formed by drawing the metal through a hole in a die or draw plate.

Wires comes in solid core, stranded or braided form usually in cross-section, wire can be made in square, hexagonal, flattened rectangular or other cross sections.

Different types of wires

1. Triplex wires
2. Main feeder Wires
3. Panel feed wires
4. Non-Metallic sheathed wires
5. Single stranded wires

1) **Triplex Wires-**It is used in single phase service drop conductor b/w power pole & weather heads. They are composed of two insulated aluminium wires wrapped with a third bore wire which is used as common neutral. The neutral is of smaller gauge & grounded at both electric meter & transformer.

2) **Main feeder Wires-**Main power feeder wires are the wires that connect the service weather head to the house. They're made with stranded as solid THHN wire and the cable installed is 25% more than the load required. THHN (Thermoplastic insulation HH- High heat resistance N-Nylon coating, resistance to change by oil or gas.

3) **Panel feeder Wires-**They are generally black insulated THHN wire. They are used to power the main junction box and the circuit breaker panels. Just like main feeder wire, the cables should be rated for 25%. more than actual load.

4) **Non-Metallic sheathed Wire-**It is used in homes and has 2-3 conductors, each with plastic insulation and a bare ground wire. The individual wires are covered with another layer of non-metallic sheathing. They are cheap and available in rating for 15 & 20 amps.

5) **Single strand Wire -**They also use THHN wire, though there are other variants. Each wire is separate and multiple wires can be drawn together through a pipe easily. Single strand wires are the most popular choice for layouts that uses pipes to contain wires.

Size selection of wires- Each application requires a certain wire size for installation and right size is determined by wire gauge. Sizing of wire is done by American wire gauge system or standard wire Gauge. For example- Single Core Wire

S.No	Nominal cross section Area of conductor (Sq.mm)	Number/Nominal Dia of cond. Strands (mm)	Thickness of Insulation (mm)	Approx. Overall Diameter	Current Carrying Capacity Conduit/Trunking(Amp.)	Unenclosed clipped directly to a surface or on a cable tray(Amp.)
1	0.5	16/0.2	0.6	2.1	4	4
2	0.75	24/0.2	0.6	2.3	8	8
3	1.00	14/0.3	0.7	2.7	12	13
4	1.5	22/0.3	0.7	3.0	14	18
5	2.5	36/0.3	0.8	3.6	20	24
6	4.00	56/0.3	0.8	4.1	26	32

Wire Lettering- The letters THHN, THWN, THW and XHHN represents the main insulation types of individual wires.

. T - Thermoplastic Insulation
.H - Heat Resistance
. HH - High Heat Resistance (up to 194°F)
. W - Suitable for Wet locations
. N - Nylon coating, resistant to damage by oil or gas
. X - Synthetic polymer that is flame- resistant

Colour codes- Different colour wires serve different purposes like

a. Black – Hot wire, for switches or outlets.
b. Red – Hot wire, for switches legs. Also for connecting wire b/w 2 hardwired smoke detectors.
c. Blue & Yellow – Hot wire, pulled in conduit Blue for 3-4-way switch application & yellow for switch legs to control fans, lights etc.
d. White – Always Neutral
e. Green & Bare copper – Only for grounding

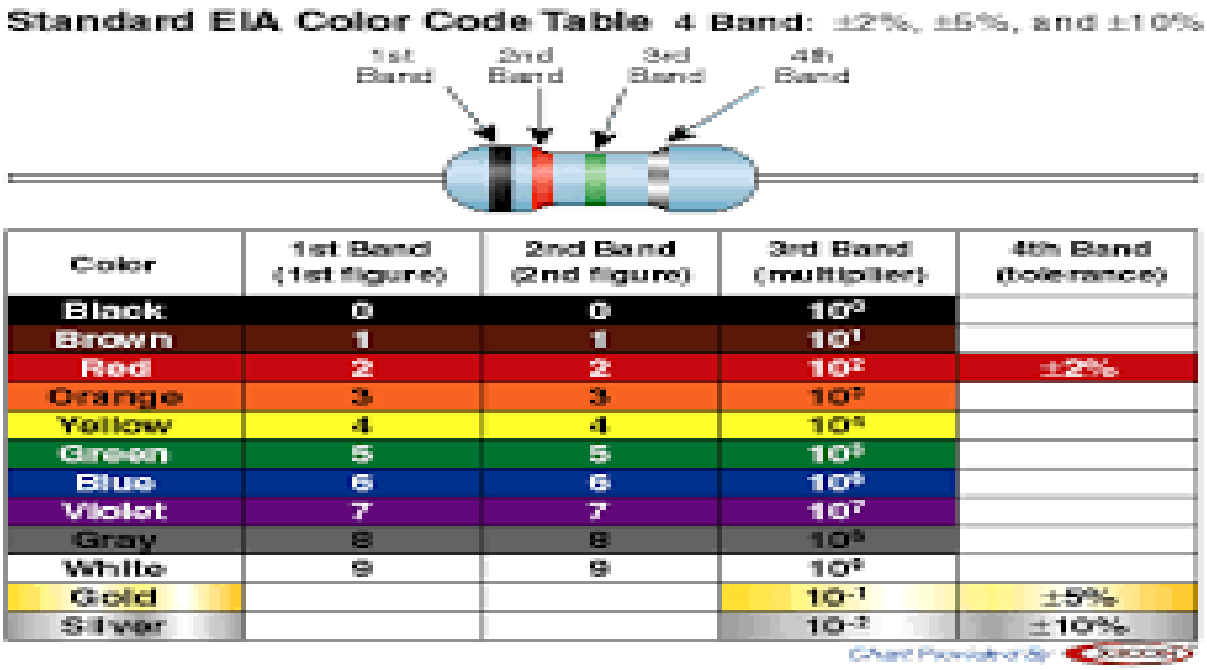
Resistance colour cooling – Since carbon composition resisters are very small in size, it is difficult to print the significant value of resistance on their bodies. Even if the value of are printed the letter will be so small that it would be difficult to read them by naked eye. Colour bands are printed on one end of the resister casing. This system of representing the resister value is called colour coding.
And in case if the resistance of the pcb get damaged , its value is to be known so colour coding is useful in that case.
To determine the value of resistance the colour bonds are always read from left to right from the end that has the bands nearer to it,

1. The first band and second band represents the first & second significant digits of the resistance value respectively.
2. The third band is the multiplier and represent the number of zeros that follow the second digit.

3. The fourth band represents the resistor tolerance. It is a measure of the precision with which the resistor was made by the manufacturer. The silver band represents +10% tolerance whereas, the golden band represents +5% tolerance. However, if there is no fourth band, it shows that the resistor has + 20% tolerance.

Table

Colour	Significant Digit	Multiplier	Tolerance
Black	0	10^0=1	--
Brown	1	10^1=10	--
Red	2	10^2=100	--
Orange	3	10^3=1000	--
Yellow	4	10^4=10,000	--
Green	5	10^5=100,000	--
Blue	6	10^6=100,0000	--
Violet	7	10^7=100,00000	--
Gray	8	10^8=10000,0000	--
White	9	10^9=100000,0000	+5%
Gold	--	10^1=0.1	+10%
Silver	--	10^2=0.2	+20%
No colour	--	--	



Colour coding can be memorised by

BB Roy Great Britain very Good Wife

Ques – A resistor has a colour band sequence, green, blue, orange, and gold. Find the range in which its value must lie depending upon the manufacturer's tolerance to suit a circuit?

Answer – Green - 5,Blue - 6,Orange – 3,Gold - ±5%
$56\times10^3\pm5\%$
=56KΩ
5% of 56k
$\frac{5}{100}\times\ 56 = 2.8k\Omega$

The value of resistance of this resistor is b/w (56+2.8) = 58.8kΩ
(56-2.8) =53.2kΩ

Cables

Electric power can be transmitted or distributed either by overhead system or by underground cables. The underground cables have several advantages such as less liable to damage through storm or lightning, low maintenance cost, less chances of faults, smaller voltage drop & better general appliance.

Major drawback is that they have greater installation cost & introduce insulation problem at high voltage.

Definition of Underground Cable-

It generally consists of one or more conductor covered with suitable insulation and surrounded by a protective layer or cover.

Construction of Cable

1. **Cores or conductors**- A cable may have one or more than one core (conductors) depending upon the type of service for which it is intended.
2. **Insulation** – Each core or conductor is provided with suitable thickness of insulation, the thickness of layer depending upon the voltage to be withstood by the cable. The commonly used materials for insulation are impregnated paper, varnished cambric rubber material compound.
3. **Metallic sheath**- To protect the cable from moisture, gases or other damaging liquids in the soil & atmosphere, a metallic sheath of lead or aluminium is provided over the insulation.
4. **Bedding** – Over the metallic sheath is applied a layer of bedding which consists of a fibrous material like jute or hessian tape. Purpose of bedding is to protect the metallic sheath against corrosion & from mechanical injury due to armouring.
5. **Armouring** – Over the bedding, armouring is provided which consists of one or two layers of galvanised steel wire or steel tape, It's purpose is to protect the cable from mechanical injury while laying it and during the course of handling.
6. **Serving** – In order to protect armouring from atmospheric conditions, a layer of fibrous material (like jute) is provided over the armouring. This is known as Serving.

Properties of Insulating Materials used in cables-

1. High insulation resistance to avoid electrical current.
2. High dielectric strength to avoid electrical breakdown of cable.
3. High mechanical strength to withstand the mechanical handling of cables.
4. Non – inflammable.
5. Low cost so as to make the underground system a viable proposition.
6. Unaffected by acids and alkalies to avoid any chemical action.

Insulating Materials-

1. Rubber
2. Vulcanised Rubber
3. Impregnated Paper
4. Varnished Cambric
5. Polyvinyl Chloride (PVC)

Classification of cables

1. Low Tension cables (L.T) – upto 1000V
2. High Tension cables (H.T) --- upto 11,000V
3. Super Tension cables (S.T) --- from 22kv to 23kv
4. Extra high – tension (E.H.T) ---- from 33kv to 66kv
5. Extra super voltage cable ---- beyond 132kv.

Cables for 3 Phase service

1. Belted cables --- upto 11kv
2. Screened cable --- from 22kv to 66kv
3. Pressure cable ----- beyond 66kv

1. Oil filled cable b) Gas pressure cable

Laying of underground cable

1. Direct Layout
2. Draw-in System
3. Solid System