Benha University

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Faculty of Engineering at Shoubra
Electrical Engineering Dept.

Undergraduate Course

Transmission and Distribution of Electrical Power

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Lecture (4)

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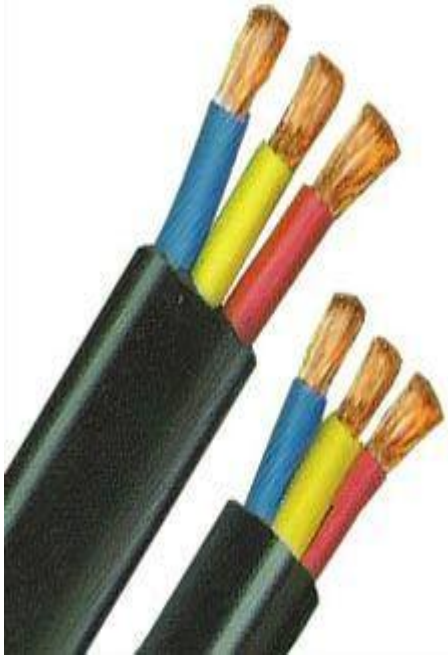
2. Wiring and Raceways

Wiring and Raceways

- Cables & Conductors
- Bus Duct
- Cable Trays



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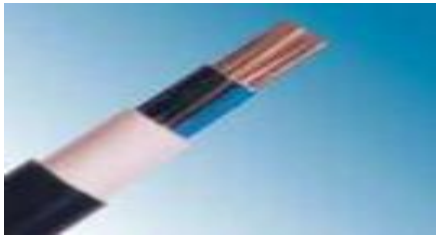
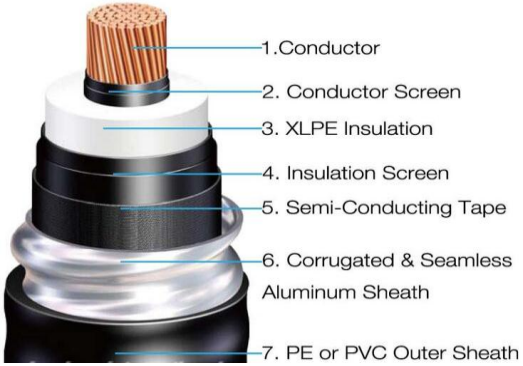
Cables Classification

Cables are classified based on multiple factors according to

Operating voltage	conductor type	insulator type	number of cores
- High voltage cables	- Copper.	- PVC.	- Single core.
- Medium voltage cables	- Aluminum.		
- Low voltage cables.		- XLPE	- Multi core





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Cable selection factors

- Maximum operating voltage.
- Insulation level.
- Maximum load.
- Maximum overload and its duration.
- Maximum short circuit and its duration.
- Voltage drop.
- Cable length.
- Cable installation (under ground - on air - on pipes).
- Maximum temperature exposed to the cable.

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Cable Rating Information

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CABLE RATING TABLE

Cable Cross Sectional Area (mm^2)	Typical Current Rating (amps)	Recommended Circuit Breaker Rating (amps)
1.5 mm^2	7.9 - 15.9A	8A
2.5 mm^2	15.9 - 22A	15A
4 mm^2	22 - 30A	20A
6 mm^2	30 - 39A	30A
10 mm^2	39 - 54A	40A
16 mm^2	54 - 72A	60A
25 mm^2	71 - 93A	80A
50 mm^2	117 - 147A	125A
70 mm^2	147 - 180A	150A
95 mm^2	180 - 216A	200A
120 mm^2	216 - 250A	225A
150 mm^2	250 - 287A	275A
185 mm^2	287 - 334A	300A
240 mm^2	334 - 400A	350A

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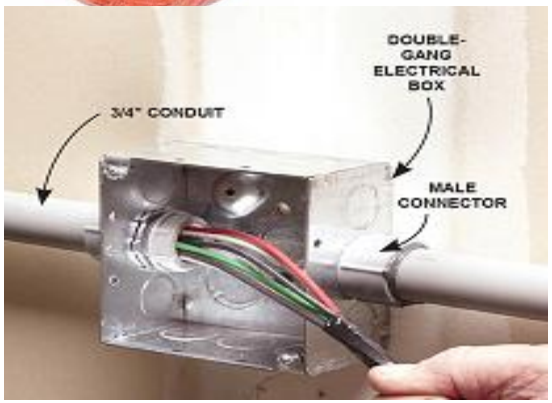
Ways to extend cables

Cable Extension

- Conduits
- Underground
- Cable Trays



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3. Protective Devices

Wiring and Raceways

Circuit Breakers

Fuses

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a) Circuit Breakers

- A **circuit breaker** is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current, typically resulting from an overload or short circuit.
- Its basic function is to interrupt current flow after a fault is detected.
- A circuit breaker can be reset (either manually or automatically) to resume normal operation.

Specifications of Circuit Breakers

- **The circuit breakers specification are determined by two values:**

- Rated current (I_{rated}) "AMP".

The maximum current passing in the circuit breaker without disconnect the CB.

- Short Circuit Capacity (SCC) "KA".

The maximum current that the circuit breaker can withstand during the short circuit without burning.

Types of Circuit Breakers

Miniature circuit breaker (MCB)

molded case circuit breaker (MCCB)

ground fault circuit breaker (GFCB)

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Differences between MCB & MCCB

	MCB	MCCB
AMP	less than 100 amps	high as 2,500 amps
Interrupting rate	interrupting rating is 18,000 amps	up to 200,000 amps
Applications	mostly installed for home use	generally utilized for commercial or industrial purposes
Circuit breaker	low-voltage circuit breakers created to meet IEC 947 standards	

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Circuit Breakers Rated Current Ratings

6, 10, 15,16, 20, 25, 32, 40,50, 63,100,
125,150,163, 200, 225, 250, 300, 400,

500, 630, 800,1000, 1200,1500,1750,

2000,2200, 2500,3000,3200,4000, 5000,6300
(Amp)

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b) Fuses

- **Fuse** is an electrical safety device that operates to provide over current protection of an electrical circuit.
- A fuse is an automatic means of removing power from a faulty system; often abbreviated to Automatic Disconnection of Supply.
- Circuit breakers can be used as an alternative design solution to fuses, but have significantly different characteristics.
- There are two fuses types: cartridge fuses, and high rupturing capacity.

Fuses Types

Fuses Types

Cartridge Fuses

High Rupturing Capacity

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Differences between Cartridge Fuses & High Rupturing Capacity

	Cartridge Fuses	High Rupturing Capacity
Function	protect electrical appliances such as motors, air-conditions, refrigerator, pumps	used for short circuit protection in high voltage switchgear for 50 to 60 Hz frequency range
Rating	available up to 600A and 600V AC	2, 4, 6, 10, 16, 25, 30, 50, 63, 80, 100, 125, 160, 200, 250, 320, 400, 500, 630, 800, 1000, and 1250 amperes.
Application	used in industries, commercial as well as home distribution panels.	* Used in High Voltage motors up to 3 MW * Capacitors up to 1200 kVAR * Cable feeders.

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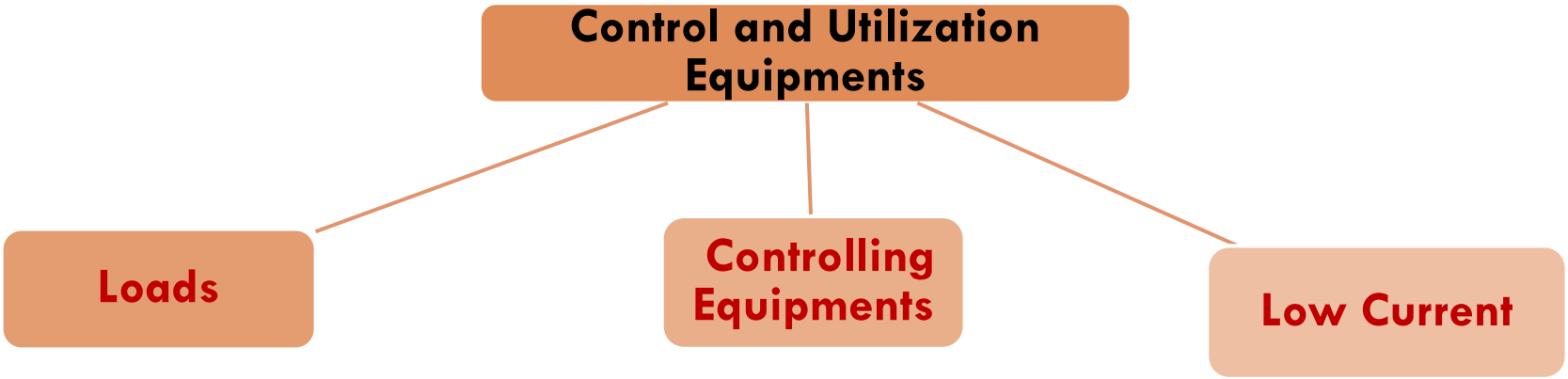
4. Control and Utilization Equipments



- Lighting.
- Air conditions.
- Elevators.
- Escalators
- Sockets.

. Dimmer
. Contactors.

. Fire alarm.
. Sounds.
. CCTV.
. Fire Fighting
. Telephone

Electric Installation Design Regulations and Standards

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Regulations & Standards

- **Regulations**

In most countries electrical installation shall comply with more than one set of regulations, issued by national authorities or by recognized private bodies.

- **Standards**

Standards are used by a diverse range of organizations to enhance their products and services, improve safety and quality, meet industry best practice, and support trade into existing and new markets, (e.g. IEC, IEEE, and EC)

Regulations & Standards History

- The implementation of standards in industry and commerce became highly important with the onset of the Industrial Revolution.
- Henry Maudslay developed the first industrially practical screw-cutting lathe in 1800, which allowed for the standardization of screw thread sizes for the first time.
- Maudslay's work, as well as the contributions of other engineers, accomplished a modest amount of industry standardization.
- Joseph Whitworth's screw thread measurements were adopted as the first national standard by companies around the country in 1841. It came to be known as the British Standard Whitworth, and was widely adopted in other countries.

- The Engineering Standards Committee was established in London in 1901 as the world's first national standards body.
- After the First World War, similar national bodies were established in other countries.
- The Detaches was set up in Germany in 1917, followed by its counterparts.
- The American National Standard Institute and the French Commission Permanente de Standardization, both in 1918.

International Standards

1. **International Electro technical Commission (IEC)**

- **IEC** is the world's leading organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

- **IEC** provides a platform to companies, industries and governments for meeting, discussing and developing the International Standards they require.

2. **Institute of Electrical and Electronics Engineers (IEEE)**

- An organization that develops global standards in a broad range of industries.
- **IEEE** has developed standards for over a century, through a program that offers balance, openness, fair procedures, and consensus. Technical experts from all over the world.