1// Active → provides energy (gives time e.g. voltage source, current source)
Passive → takes energy. e.g. capacitor, inductor

Unilateral → current flow one direction e.g, diode transistor
Bilateral → e.g, resistor, capacitor
Lumped → resistors, capacitors & inductor can be separated physically.
Distributed → reverse of lumped.
e.g. coaxial cable

Linear & Non-Linear
Time Variant ⇒ function of time. input is
Time Invariant ⇒ not function of time.

Linear n/w ⇒ follow the principle of superposition
Non- " " does not " " " "

2//	HT ⇒ High Tension	LT ⇒ Low Tension.
1.	when bulk supply is needed e.g, 11 kw, 33 kw, 132 kw and above	
2.	High voltage line	low voltage line
3.	In 1 phase → 230 V In 3 " → 400 V	→
4.	Used in industries, universities, hostels	Used in house
5.	Small current is used with very high voltage	where low voltage is used with very high current.
6.	Uses step-up transformer	Uses step-down transformer
7.	HT panels are installed in both outdoor and indoor.	Only indoor

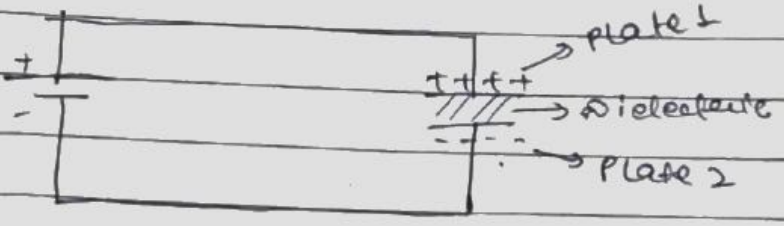
Fixed | Polarized | Variable

DATE / /
PAGE

* Capacitor :-

→ Two-terminal electrical device that can store energy in form of electric charge.
→ consists of 2-electrical conductors that are separated by a distance.
→ the space bet^n them is filled by vacuum or with insulating material known as dielectric.
→ Unit :- F (farad)
→ the effect of capacitor called capacitance.

* working of capacitor :-



→ let us consider 2-parallel Plate capacitor with a di-electric bet^n them.
→ Apply voltage V, plate 1 has (+ve) charge & plate 2 has (-ve) charge
→ When these plates are applied with voltage they will carry (+ve) charge from battery at plate 1 and (-ve) charge on plate 2.
→ for some time voltage is applied and within that time capacitor gets charged called charging time of capacitor.
→ After some time when capacitor has reached its max^m limit of charging then we will cut the supply.
→ For certain time, the two plates hold (+ve) & (-ve) charge, thus capacitor acts as a source of electric charge.
→ If these plates are connected to a load, the current flows from plate 1 to plate 2 until all charges are dissipated from both plates.

This time of discharging of capacitor is called time of dissipation.

* Types of capacitor :-

1. Electrolytic capacitor ⇒ used when large capacitor values are required

   1st electrode → thin metal film
   Dielectric → thin layer of oxide
   2nd electrode → a semi-liquid electrolyte sol° in form of jelly.

2. Mica capacitor ⇒ 2-types (i) Clamped (ii) Mica
   very stable chemically, electrically and mechanically.

3. Paper capacitor ⇒ Two thin foil sheets and separated by paper.
   The sandwich of thin foils & paper rolled into cylindrical shaped and then enclosed into plastic capsule.

4. Film capacitor ⇒ uses thin plastic as di-electric
   e.g. Polyster film, ⇒ extremely thin
   metallized film, PTE film

5. Non-Polarized ⇒

   Plastic foil
   non-polarized by nature.

   Electrolytic
   generally 2-capacitors in the series which are back to back and hence, the result is in the non-polarized with half-capacitance

6. Ceramic capacitor ⇒ uses ceramic material as di-electric
   The ceramics are of the 1st material to use in the production of capacitor as an insulator.

9/ Harmonics :-

→ Harmonics are current or voltages with frequencies that are integer multiple of fundamental power frequency. for e.g. if the first fundamental frequency is 60Hz, then the 2nd is 120 Hz and 3rd is 180Hz

→ Harmonics are a result of non-linear loads that converts AC the voltage to DC

Source	Typical Harmonics
6-pulse drive/ Rectifier	5, 7, 11, 13, 17, 19, ..
12 - - - -	11, 13, 23, 25
18 - - -	17, 19, 35, 37
24 - - -	23, 25, 47, 49
DC-motor	5, 7, 11, 19, 17, 19
LED	3, 5, 7, 9, 11, 13

* Illumination :-

The luminous flux received by surface per unit area is called Illumination.

Denoted by 'E' and measured in LUX.

$$E = \frac{\text{Luminous Flux}}{\text{Area}}$$

Luminous Flux → the light energy radiated out per second from body in form of luminous light waves.

Unit :- Lumen

1 Lumen = 0.0016 watt.

→ Illumination describes the measurement of amount of light falling on and spreading over a given surface area. while brightness is visual perception. of this target and physiological sensation of light

* Power correction Factors :-

→ Power factor is the measure of how efficiently, incoming power is used in an electrical installation.

→ Ratio of active power to Apparent power

active power: power needed for useful work; Watt / kilowatt

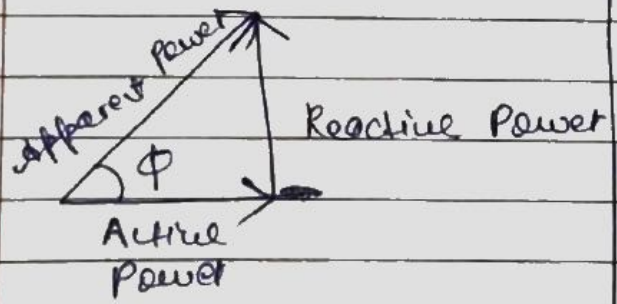
Apparent power: vector sum of active and reactive power; Volt Amperes (VA)

→ Power factor correction aims at to improve power factor and ∴ power quality.

→ Reduces load on electrical distribution system, ↑ energy efficiency and ↓ electrical costs.

→ Also ↓ chances of failure of equipments.

→ Capacitors are used to improve power factor because capacitors store in energy in the form of voltage that helps in reducing reactive power



reactive power: volt-ampere-reactive (KVAR)

→ which does not take part in output generation

→ maintain Electro-magnetic field

→ the cosine angle bet^n voltage & current in a circuit is power factor.

should be close to unity (1).

	Vapour Compression	Vapour Absorption
1.	Refrigerent vapour is compressed	Heated and Absorbed
2.	Mechanical work supply to the compressor	Heat energy supply to the generator
3.	More compression work is required	less
4.	COP High	COP Low
5.	Limited upto 1000 tons	Above 1000 tons
6.	Noisy	Quiet operation
7.	More leakage due to high pressure	Almost there is no leakage
8.	High operation cost	low cost
9.	Suitable Refrigerant R-12	Ammonia.

(*) HVAC → Stands for Heating, Ventilation and Air Conditioning.

Energy saving opportunities:

→ HVAC consumes nearly 50-60% power in any building.

Strategies:

→ Selecting the right temperature for AC.

→ Building orientation: ① Insulation on Roof ⑤ Use of non-toxic & recycled materials

② Double glass

③ No leakage

④ Fresh air intake should be sufficient.

Energy saving opportunities in fans and Blowers.

→ For fans: ① Minimizing Pressure.

② Control density

③ fan efficiency

④ Proper fan sizing

⑤ Adjustable speed drives

⑥ High efficiency belts.

for fans: ① When installed, make sure that the blades are properly balanced

② purchase energy efficient fans.

③ Use electronic regulator in place of conventional regulator

④ Use fans at low speed.

⑤ Turn off fans when not required.

⑥ Adjust the direction so that air blows downward.

⑧ Maintain, repair, use in good condition.

⑨ Use windows to allow natural air.

⑩ use properly designed blade fans.

* Fans / Blowers:
→ Provide air for industrial process requirements & ventilation.
Types of industrial fans and blowers:
→ Axial fans: The blades circulate parallel to air flow.
→ Positive displacement fans: Consists of multiple co-rotating shafts that mesh to move air and gases in a controlled manner.
→ Centrifugal fans: The fan blade rotates perpendicular to air flow.
→ Crossflow fans: Used where space is small.
→ Exhaust fans: Draw air out of a building.
→ Fans for personal workspace.
Both blowers and fans are used for cooling & air circulation.

Benefits of Green Buildings:
Also called Enviornment Building. Preserves precious resources.
Benefits:
① Reduction of natural resource consumption.
② Reduction of operation costs.
③ Health / comfort and safety for all residents.
④ Energy optimization.
⑤ Reduction of Energy Consumption.
⑥ Better Indoor Air Quality.
⑦ Increased productivity of occupants.
⑧ Enviornment-friendly.
⑨ Min. Quantity of Chemicals used.
⑩ Impact on Enviornment (negative) is small.

(x). Centrifugal Pumps:

→ Mechanical device designed to move a fluid by means of rotational Energy.

→ Impeller is the key component.

→ Consists of a series of curved vanes.

→ ~~xxxxxxxx~~ fluid enters the impeller, and exits along the circumference b/w the vanes.

→ Rotational motion accelerates the fluid out.

(x). Cooling Towers:

→ designed to remove heat from a building by spraying water through the tower.

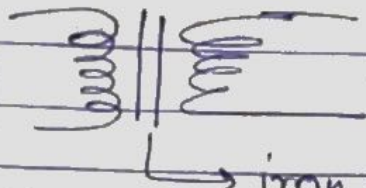
→ Air comes in from the sides of tower and passes through falling water.

→ As the air passes through water, heat is exchanged and some of the water evaporates.

→ The cooled water is collected at the bottom of the tower and pumped back into the building.

(*) Transformers.

→ Electrical devices that are used to convert AC current from high to low or low to high.
→ Takes input as AC.
→ Works on the principle of electromagnetic induction.



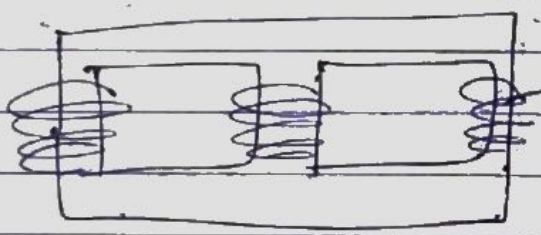
→ Creates AC voltage in the secondary coil from the current flowing in primary coil.
→ Working Principle: Faraday's law of Electromagnetic Induction.
→ Transformation Ratio K = $\frac{\text{Secondary Voltage}}{\text{Primary voltage}}$. $K = \frac{E_2}{E_1} = \frac{N_2}{N_1}$
→ Efficiency: $\frac{\text{Power Out}}{\text{Power In}} \times 100$.

→ Types: Step Up, Step Down, Isolation.
- Step Up: converts primary voltage to lower voltage.
- Step Down: converts primary voltage to higher voltage.

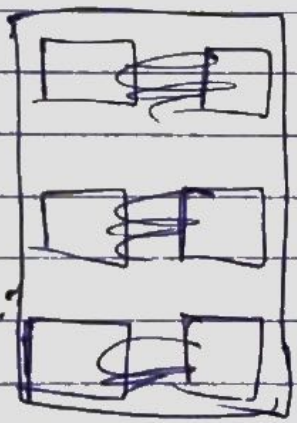
(*) Single Phase Transformer: Transfers electrical energy from one circuit to another without change in frequency.
→ Mutual Induction.
→ Core allows maximum flux to flow through it.
→ Only works on Single Phase power.

Electric Energy → Magnetic → Electrical Energy.
Same as normal transformer.

(*) Three phase shell type transformer:
→ Required to step up / step down 3 phase voltages.
→ Can be constructed in following ways:
(a). 3 seperate 1 phase transformers can be connected.
(b). A single 3 phase transformer can be constructed.



Core Type Construction



Shell Type: Stacking 3 single phase transformers.

Shell Type

(iii) DC Motor: Converts Electrical → Mechanical Energy.

→ use magnetic fields that occur from electrical currents generated, which powers the movement of rotor.

Basic working principle: Whenever a current carrying conductor is placed in a magnetic field, it experiences mechanical force.

Direction of force is determined by Fleming's Right Hand Rule.

Working

→ When armature windings are connected to DC supply electric current sets up in winding.

→ Magnetic field may be provided by using field windings or permanent magnet.

→ Armature experiences a force.

(*) Induction type AC Motors, Electrical → Mechanical.

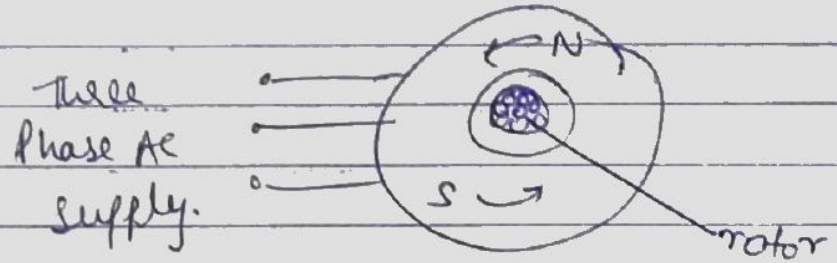
→ AKA Asynchronous motor

→ The electric current in the rotor is obtained by electromagnetic induction.

→ Induction motor can be made without electrical connections to the rotor.

→ Three phase induction motors are self starting, reliable & economical.

→ Single phase are used for smaller loads.



Cables: construction of cables, types of cables, application of cables.

A cable consists of an aluminium conductor covered by a screening layer.

Types of Cable:

Fiber optic Cable: It consists of a bundle of glass threads which are used to transmitt the messages.

Twisted Pair Cable: It is a type of ordinary wiring which connects home and many business computers

Coxial Cable: Coxial cable, or coax cable is another type of copper cable which has an inner conductor surronded by foam insulation.

Choosing among coxial, twisted and fiber optic cable mainly depends on your needs and network topology.

Applications of Cable:

used in process controls
transmission of signals
computers and control systems.