BRANCH:-ECE **RRB-JE CBT 2** **UNIT 1**

NOTE:-CONDUCTOR/SEMICONDUCTOR/INSULATOR ALRADY DONE IN CLASS

RELAYS

Relays are the primary protection as well as switching devices in most of the control processes or equipments. All the relays respond to one or more electrical quantities like voltage or current such that they open or close the contacts or circuits. A relay is a switching device as it works to isolate or change the state of an electric circuit from one state to another.

Different Types of Relays

Classification or the types of relays depend on the function for which they are used. Some of the categories include protective, reclosing, regulating, auxiliary and monitoring relays.

Protective relays continuously monitor these parameters: voltage, current, and power; and if these parameters violate from set limits they generate alarm or isolate that particular circuit. These types of relays are used to protect equipments like motors, generators, and transformers, and so on.

Reclosing relays are used to connect various components and devices within the system network, such as synchronizing process, and to restore the various devices soon after any electrical fault vanishes, and then to connect transformers and feeders to line network. Regulating relays are the switches that contacts such that voltage boosts up as in the case of tap changing transformers.

Auxiliary contacts are used in circuit breakers and other protective equipments for contact multiplication. Monitoring relays monitors the system conditions such as

direction of power and accordingly generates the alarm. These are also called directional relays.

Different Types of Relays

Depending on the operating principle and structural features relays are of different types such as electromagnetic relays, thermal relays, power varied relays, multi-dimensional relays, and so on, with varied ratings, sizes and applications.

1. Electromagnetic Relays

These relays are constructed with electrical, mechanical and magnetic components, and have operating coil and mechanical contacts. Therefore, when the coil gets activated by a supply system, these mechanical contacts gets opened or closed. The type of supply can be AC or DC.

DC vs AC Relays

Both AC and DC relays work on the same principle as electromagnetic induction, but the construction is somewhat differentiated and also depends on the application for which these relays are selected. DC relays are employed with a freewheeling diode to de-energize the coil, and the AC relays uses laminated cores to prevent eddy current losses.The very interesting aspect of an AC is that for every half cycle, the direction of the current supply changes; therefore, for every cycle the coil loses its magnetism since the zero current in every half cycle makes the relay continuously make and break the circuit. So, to prevent this – additionally one shaded coil or another electronic circuit is placed in the AC relay to provide magnetism in the zero current position.

Attraction Type Electromagnetic Relays

These relays can work with both AC and DC supply and attract a metal bar or a piece of metal when power is supplied to the coil. This can be a plunger being drawn towards the solenoid or an armature being attracted towards the poles of an electromagnet as shown in the figure. These relays don’t have any time delays so these are used for instantaneous operation.

Induction Type Relays

These are used as protective relays in AC systems alone and are usable with DC systems. The actuating force for contacts movement is developed by a moving conductor that may be a disc or a cup, through the interaction of electromagnetic fluxes due to fault currents.These are of several types like shaded pole, watt-hour and induction cup structures and are mostly used as directional relays in power-system protection and also for high-speed switching operation applications.

Magnetic Latching Relays

These relays use permanent magnet or parts with a high remittance to remain the armature at the same point as the coil is electrified when the coil power source is taken away.

2. Solid State Relays

Solid State uses solid state components to perform the switching operation without moving any parts. Since the control energy required is much lower compared with the output power to be controlled by this relay that results the power gain higher when compared to the electromagnetic relays. These are of different types: reed relay coupled SSR, transformer coupled SSR, photo-coupled SSR, and so on.The above figure shows a photo coupled SSR where the control signal is applied by LED and it is detected by a photo-sensitive semiconductor device. The output form this photo detector is used to trigger the gate of TRIAC or SCR that switches the load.

3. Hybrid Relay

These relays are composed of electromagnetic relays and electronic components. Usually, the input part contains the electronic circuitry that performs rectification and the other control functions, and the output part include electromagnetic relay.

4. Thermal Relay

These relays are based on the effects of heat, which means – the rise in the ambient temperature from the limit, directs the contacts to switch from one position to other. These are mainly used in motor protection and consist of bimetallic elements like temperature sensors as well as control elements. Thermal overload relays are the best examples of these relays.

5. Reed Relay

Reed Relays consist of a pair of magnetic strips (also called as reed) that is sealed within a glass tube. This reed acts as both an armature and a contact blade. The magnetic field applied to the coil is wrapped around this tube that makes these reeds move so that switching operation is performed.

Based on dimensions, relays are differentiated as micro miniature, subminiature and miniature relays. Also, based on the construction, these relays are classified as hermetic, sealed and open type relays. Furthermore, depending on the load operating range, relays are of micro, low, intermediate and high power types.

Relays are also available with different pin configurations like 3 pin, 4 pin and 5 pin relays. The ways in which these relays are operated is shown in the below figure. Switching contacts can be SPST, SPDT, DPST and DPDT types. Some of the relays are normally open (NO) type and the other are normally closed (NC) types.

MCB

A miniature circuit breaker (MCB) automatically switches off electrical circuit during an abnormal condition of the network means in overload condition as well as faulty condition.Nowadays we use an MCB in low voltage electrical network instead of a fuse. The fuse may not sense it but the miniature circuit breaker does it in a more reliable way. MCB is much more sensitive to overcurrent than

fuse.Handling an MCB is electrically safer than a fuse. Quick restoration of supply is possible in case of a fuse as because fuses must be re-wirable or replaced for restoring the supply. Restoration is easily possible by just switching it ON. Let's look at the working of the miniature circuit breaker.

The working principle of MCB

Whenever continuous overcurrent flows through MCB, the bimetallic strip is heated and deflects by bending. This deflection of bimetallic strip releases a mechanical latch. As this mechanical latch is attached with the operating mechanism, it causes to open the miniature circuit breaker contacts, and the MCB turns off thereby stopping the current to flow in the circuit. To restart the flow of current the MCB must be manually turned ON. This mechanism protects from the faults arising due to overcurrent or overload.

But during short circuit condition, the current rises suddenly, causing electromechanical displacement of plunger associated with a tripping coil or solenoid. The plunger strikes the trip lever causing immediate release of latch mechanism consequently open the circuit breaker contacts. This was a simple explanation of a miniature circuit breaker working principle.An MCB is very simple, easy to use and is not generally repaired. It is just easier to replace. The trip unit is the main part, responsible for its proper working. There are two main types of trip mechanism. A bi-metal provides protection against overload current and an electromagnet provides protection against short-circuit current.

MCB operation

If the circuit is overloaded for a long time, the bi-metallic strip becomes overheated and deformed. This deformation of Bi-metallic strip causes, displacement of latch point. The moving contact of the MCB is arranged by means

of spring pressure, with this latch point, that a little displacement of latch causes, release of spring and makes the moving contact to move for opening the MCB. The current coil or trip coil is placed so that during short circuit fault the magneto-motive force (mmf) of the coil causes its plunger to hit the same latch point and make the latch to be displaced. Again, when operating lever of the miniature circuit breaker is operated by hand, that means when MCB goes off position manually, the same latch point is displaced as a result moving contact separated from fixed contact in the same manner.

It may be due to deformation of a bi-metallic strip, or increased mmf of a trip coil or maybe a manual operation, the same latch point is displaced and same deformed spring is released, which ultimately responsible for movement of the moving contact. When the moving contact separated from fixed contact, there may be a high chance of arc. This arc then goes up through the arc runner and enters arc splitters and is finally quenched. When we switch it on, we reset the displaced operating latch to its previous on position and the MCB is ready for another switch off or trip operation.

NOTE:- When a high current or voltage is interrupted, an arc is generated. The length of the arc is generally proportional to the voltage while the intensity (or heat) is proportional to the current. This arc must be contained, cooled and extinguished in a controlled way, so that the gap between the contacts can again withstand the voltage in the circuit. Different circuit breakers use vacuum, air, insulating gas, or oil as the medium the arc forms in. Different techniques are used to extinguish the arc including:

- Lengthening or deflecting the arc
- Intensive cooling (in jet chambers)
- Division into partial arcs
- Zero point quenching (contacts open at the zero current time crossing of the AC waveform, effectively breaking no load current at the time of opening. The zero crossing occurs at twice the line frequency; i.e., 100 times per second for 50 Hz and 120 times per second for 60 Hz AC.)
- Connecting capacitors in parallel with contacts in DC circuits.

Finally, once the fault condition has been cleared, the contacts must again be closed to restore power to the interrupted circuit.

Electrical connector

An **electrical connector** is an electromechanical device used to join electrical terminations and create an electrical circuit. Most electrical connectors have a gender – i.e. the male component, called a *plug*, connects to the female component, or *socket*. The connection may be removable (as for portable equipment), require a tool for assembly and removal, or serve as a permanent electrical joint between two points. An adapter can be used to join dissimilar connectors.

Thousands of configurations of connectors are manufactured for power, data, and audiovisual applications.Electrical connectors can be divided into four basic categories, differentiated by their function

- **inline** or **cable** connectors permanently attached to a cable, allowing it to be plugged into another terminal (either a stationary instrument or another cable)
- **chassis** or **panel** connectors which are permanently attached to a piece of equipment, allowing users to connect a cable to a stationary device
- **PCB mount** connectors soldered to a printed circuit board, providing a point for to a cable or wire to be attached(e.g. pin headers, screw terminals, board-to-board connectors)
- **splice** or **butt** connectors (primarily insulation displacement connectors) which permanently join two lengths of wire or cable.

Materials of connector

Electrical connectors essentially consist of two classes of materials: conductors and insulators. Properties important to conductor materials are conductivity, mechanical strength, formability, and resilience Insulators must have a high electrical resistance, withstand high temperatures, and be easy to manufacture for a precise fit.

Electrodes in connectors are usually made of copper alloys, due to their good conductivity and malleability. Alternatives include brass, phosphor bronze, and beryllium copper. The base electrode metal is often coated with another inert metal such as gold, nickel, or tin This increases the electrical conductivity and durability. For example, copper alloys have favorable mechanical properties for electrodes, but are hard to solder and prone to corrosion. Thus, copper pins are usually coated with gold to alleviate these pitfalls, especially for analog signals and high reliability applications

Difference Between Cell and Battery

Cell	Battery
A cell is a single unit device which converts chemical energy into electric energy.	A battery usually consists of group of cells.
Depending on the types of electrolytes used, a cell is either reserve, wet or dry types. Cell also includes molten salt type.	A battery is either a primary battery or a secondary battery meaning it is rechargeable or non-chargeable.
A cell is usually light and compact as it has a single unit.	Battery normally consists of several cells thus giving it a bigger size and is bulky.
A cell supplies power for a shorter period of time.	A battery can supply power long durations.
A cell is used mostly for lighter tasks which requires less energy. It is used in lamps, clocks, lamp, etc.	A battery is mostly used for heavy duty tasks. It is used in inverters, automobiles, inverter, etc.
Cells are usually cheap	Batteries are much costlier.

What is a battery

A Battery is a device consisting of one or more electrical cells that convert chemical energy into electrical energy. Every battery is basically a galvanic cell where redox reactions take place between two electrodes which act as the source of the chemical energy.

Battery types

Batteries can be broadly divided into two major types.

- Primary Cell / Primary battery
- Secondary Cell / Secondary battery

Based on the application of the battery, they can be classified again. They are:

- Household Batteries

These are the types of batteries which are more likely to be known to the common man. They find uses in everything from torches, clocks to cameras. But then again these batteries are subdivided into two, they are:

- Rechargeable batteries Nickel
  Examples: Cadmium batteries, Lithium Ion
- Non-rechargeable batteries
  Examples: Silver oxide, Alkaline & carbon zinc

- Industrial Batteries

  These batteries are built to serve certain high need & heavy duty applications. Some of their applications include railroad, backup power and more for big companies. Some examples are:
  Nickel Iron
  Wet Nickel Cadmium (NiCd)

- Vehicle Batteries

  These are more user-friendly and a less complicated version of the industrial batteries. They are more user-friendly and used to power cars, motorcycles, boats & other vehicles. Some examples are:
  Lead acid batteries

Rechargeable battery

A **rechargeable battery**, **storage battery**, **secondary cell**, or **accumulator** is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells. The term "accumulator" is used as it accumulates and stores energy through a reversible electrochemical reaction. Rechargeable batteries are produced in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network. Several different combinations of electrode materials and electrolytes are used, including lead–acid, nickel–cadmium (NiCd), nickel–metal hydride (NiMH), lithium-ion (Li-ion), and lithium-ion polymer(Li-ion polymer).

Rechargeable batteries typically initially cost more than disposable batteries, but have a much lower total cost of ownership and environmental impact, as they can be recharged inexpensively many times before they need replacing. Some rechargeable battery types are available in the same sizes and voltages as disposable types, and can be used interchangeably with them.

COMPLETE LIST

Primary cells or non-rechargeable batteries	Secondary cells or rechargeable batteries

• Alkaline battery (zinc manganese oxide, carbon)
• Aluminium–air battery
• Atomic battery
  ◦ Betavoltaics
  ◦ Optoelectric nuclear battery
  ◦ Nuclear micro-battery
• Bunsen cell
• Chromic acid cell (Poggendorff cell)
• Clark cell
• Daniell cell
• Dry cell
• Earth battery
• Frog battery
• Galvanic cell
• Grove cell
• Leclanché cell
• Lemon/potato battery
• Lithium battery
• Lithium air battery
• Magnesium battery
• Mercury battery
• Molten salt battery
• Nickel oxyhydroxide battery
  ◦ Oxyride battery
• Organic radical battery
• Paper battery
• Pulvermacher's chain
• Silver-oxide battery
• Solid-state battery
• Sugar battery
• Voltaic pile
  ◦ Penny battery
	• Aluminium-ion battery
	• Carbon Battery
	  ◦ Single Carbon Battery[1]
	  ◦ Dual carbon battery[2][3][4]
	• Flow battery
	  ◦ Vanadium redox battery
	  ◦ Zinc–bromine battery
	  ◦ Zinc–cerium battery
	• Lead–acid battery
	  ◦ Deep cycle battery
	  ◦ VRLA battery
	  ◦ AGM battery
	  ◦ Gel battery
	• Glass battery
	• Lithium-ion battery
	  ◦ Lithium ion lithium cobalt oxide battery (ICR)
	  ◦ Lithium ion manganese oxide battery (IMR)
	  ◦ Lithium ion polymer battery
	  ◦ Lithium iron phosphate battery
	  ◦ Lithium–sulfur battery
	  ◦ Lithium–titanate battery
	  ◦ Thin film lithium-ion battery
	  ◦ Lithium ceramic battery [5] [6]
	• Magnesium-ion battery
	• Metal–air electrochemical cells
	  ◦ Lithium air battery
	  ◦ Aluminium–air battery
	  ◦ Germanium air battery
	  ◦ Calcium air battery
	  ◦ Iron air battery
	  ◦ Potassium-ion battery
	  ◦ Silicon–air battery

- Trough battery
- Water-activated battery
- Weston cell
- Zinc–air battery
- Zinc–carbon battery
- Zinc chloride battery

- Zinc–air battery
- Tin air battery
- Sodium-air battery
- Beryllium air battery
- Molten salt battery
- Nickel–cadmium battery
  - Nickel–cadmium battery vented cell type
- Nickel hydrogen battery
- Nickel–iron battery
- Nickel metal hydride battery
  - Low self-discharge NiMH battery
- Nickel–zinc battery
- Organic radical battery
- Polymer-based battery
- Polysulfide bromide battery
- Potassium-ion battery
- Rechargeable alkaline battery
- Rechargeable fuel battery
- Sand battery
- Silicon air battery
- Silver-zinc battery
- Silver calcium battery
- Silver-cadmium battery
- Sodium-ion battery
- Sodium–sulfur battery
- Solid-state battery [7]
- Super iron battery
- UltraBattery