ELECTRAZINE

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DEPARTMENT OF ELECTRICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY AGARTALA

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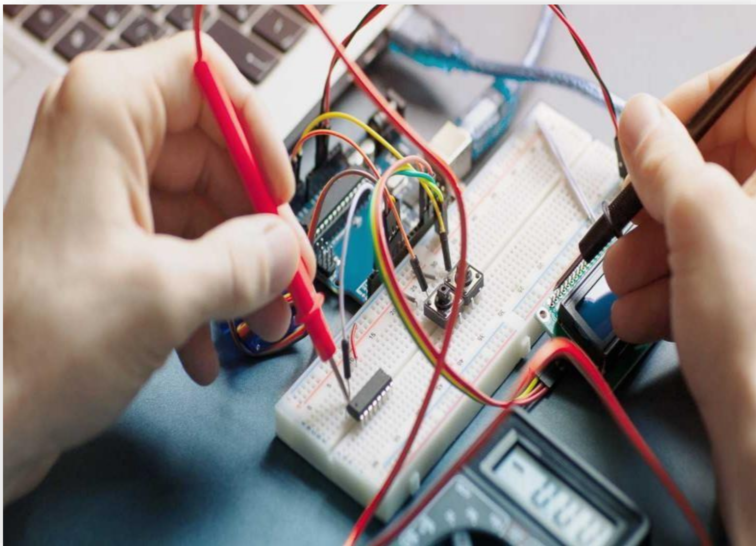


FROM THE EDITOR

Dear Reader,

Greetings to you.

It is a pleasure that the ELECTRAZINE issue of this year is being published in time. To ensure uninterrupted publications of the magazine, the editorial board has been reformed including some really talented group of students in it. The present issue is the first product of the newly formed editorial board. All new essence, reflecting the new editorial board, can be felt to be omnipresent in this issue.

In this issue of ELECTRAZINE, our students have put forward some amazing pieces of writing displaying their creative thinking and writing skills. It is indeed a lovely experience to view these enthusiastic and highly potential young minds voicing their feelings through their technical/non-technical write ups, poems, drawings and paintings. I would definitely like to convey my heartiest thanks to the entire editorial team for their hard work round the clock to make this edition come in life in time.

I am confident that this magazine would find warm appreciation and welcome for all.

Sumita Deb

FROM ELECTRATEAM

"

You learn to rely on a few basic movements and use your voice to the greatest extent possible to convey your emotions. So there was a technical challenge and a responsibility to create a character from behind the task.

"

-HELENA CARTER

*It gives us a great pleasure and satisfaction to present to you the Eighth edition of the departmental magazine **ELECRAZINE.** This branch magazine in is the culmination of efforts put in by the whole editing and designing team.*

This magazine is intended to evoke a response from you. Our purpose is to use it as your mouthpiece and at the same time present the happenings of the department before you. We seek to provide you with some pages where you can unwind yourself from the daily grinds and the rigors of the technical complexities and let the creative self take over for a while. It is expected to serve as the little excuse or the tiny dose of motivation which will stir the dormant artistic creativity of the students. At the same time it is also the mean by which you can have your opinion heard and your ideas shared.

*We are indebted to **Dr. PRIYA NATH DAS** and **Dr. SUMITA DEB** for the inspiration and the kind support. A branch magazine owes a lot to the contributors and hence we are also thankful to all those who chipped in with precious contents. We have put in our best in the pursuit of publishing this magazine which would cater to the expectations of the readers but still there is always a scope of improvement and thus feedback and suggestions are always welcome.*

*We hope you all will enjoy as your turn over the leaves of **ELECTRAZINE 12.0!!***

"DESIGN IS A WAY OF LIFE, A POINT OF VIEW. IT INVOLVES THE WHOLE COMPLEX OF VISUAL COMMUNICATIONS: TALENT, CREATIVE ABILITY, MANUAL SKILL AND TECHNICAL KNOWLEDGE. AESTHETICS AND ECONOMIS, TECHNOLOGY AND PSYCHOLOGY AND INTRINSICALLY RELATED TO THE PROCESS."

- Anonymous

The Department of Electrical Engineering was established at NIT Agartala (then Tripura Engineering College) in 1965. Over the last few decades, our graduates have been serving the society in key positions and have made tremendous contributions to the development of India in its evolution from an industrial based to knowledge-based country.

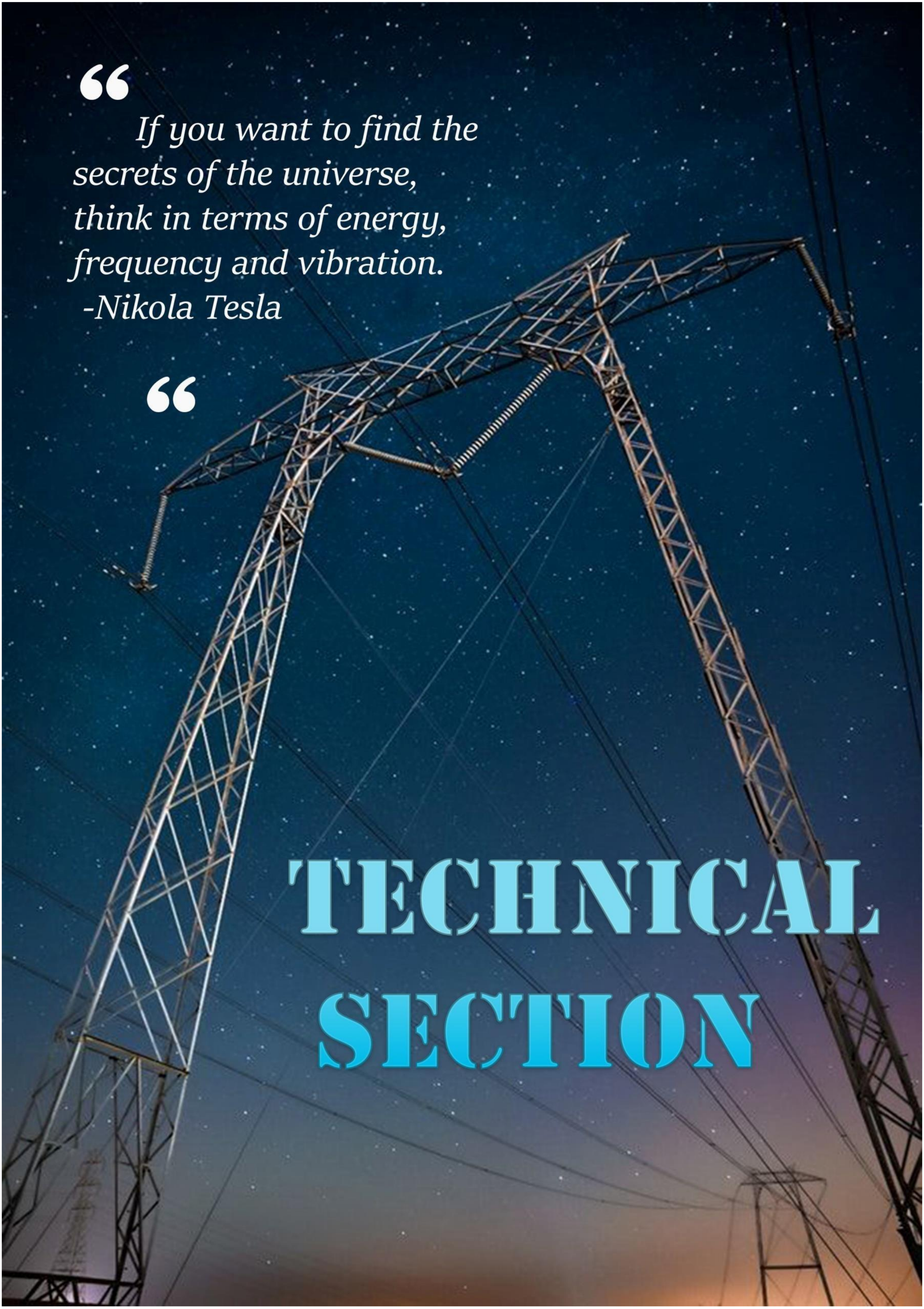
The field of Electrical Engineering encompasses many exciting technologies: Microelectronics, HV Transmission, Power Generation etc, which have been the fastest growing and most challenging technologies that enable the development of the modern information-based society.

Thus I feel very happy in presenting ELECTRAZINE on the eve HAPPY NEW YEAR. In a subtle sense it is the celebration of joy and rejuvenates us to struggle harder in our lives. This magazine brings us an opportunity to the students to celebrate their individuality by showcasing their hidden talent and helps them to unleash their potential.

I hope this magazine will be enjoyed by all of us as before.

Dr. Priya Nath Das

HOD, Electrical Engineering


"If you want to find the secrets of the universe, think in terms of energy, frequency and vibration."
-Nikola Tesla
TECHNICAL
SECTION

WIMP – the potential Dark Particle

ANINDITA JAMATIA,
ASSISTANT PROFESOR

Extragalactic systems like spiral galaxies and cluster of galaxies exhibit mass discrepancies. The application of Newton's Law of Gravity to the observed stars and gas fails to explain the rapid observed motions of stars inside galaxies. This leads to the inference that some form of invisible mass - *dark matter* - dominates the dynamics of the universe. It is believed that approximately 85% of matter in the Universe is dark matter.Without an unseen blob of dark matter, galaxies would fly apart.

Dark Particle Candidates:

The *concept* of dark matter is not falsifiable. Individual candidates for the dark matter should be tested and falsified. For example, it was once reasonable to imagine that innumerable brown dwarfs could be the dark matter. That is no longer true - the brown dwarf hypothesis has been falsified. If we exclude one candidate, we are free to make up another one. This is exactly what Particle physicist do. Other possible candidates are more exotic objects, like small primordial black holes (*primordial* meaning that they have been produced before atomic nuclei have formed in the early universe, while black holes we usually talk about are produced from collapsing heavy stars - much later in the history of the universe), or even the gravitational force that comes to us from a universe outside our own.

The candidates fall roughly into three categories:

WIMPs: WIMP-like particles are predicted by R parity conserving supersymmetry, a popular type of extension to the standard model of particle physics All Standard Model particles have R-parity of +1 while supersymmetric particles have R-parity of −1. With R-parity being preserved, the lightest supersymmetric particle (LSP)(100 GeV– 1 TeV) cannot decay and is eventually produced in the decay chain of all other superpartners. This stable LSP (if it exists) may therefore account for the observed missing mass of the universe that is generally called dark matter. WIMP-like particles are also predicted by universal extra dimension and little Higgs theories.

After WIMPs, the next obvious candidate is Axions, but in contrast to the WIMP it is an extremely light particle. To make it still a valid dark matter candidate, it cannot have been produced during the initial phase of the Big Bang, but rather in a later period.

Massive Compact Halo Objects (MACHOs) are large, condensed objects such as black holes, neuron stars, white dwarfs etc. The search for these consists of using gravitational lensing to see the effect of these objects on background galaxies. Most experts believe that the constraints from those searches rule out MACHOs as a viable dark matter candidate.

The WIMP Miracle

When properties of LSP is used to calculate the number of LSPs still be around today, it matches closely to the amount of dark matter experimentally observed, which can’t be mere coincidence.

Simulations of a universe full of cold dark matter produce galaxy distributions that are roughly similar to what is observed. WIMPs fit the model of a relic dark matter particle from the early Universe, when all particles were in a state of thermal equilibrium For sufficiently high temperatures, such as those existing in the early Universe, the dark matter particle and its antiparticle would have been both forming from and annihilating into lighter particles. As the Universe expanded and cooled, the average thermal energy of these lighter particles decreased and eventually became insufficient to form a dark matter particle-antiparticle pair. The annihilation of the dark matter particle-antiparticle pairs, however, would have continued, and the number density of dark matter particles would have begun to decrease exponentially. Eventually, however, the number density would become so low that the dark matter particle and antiparticle interaction would cease, and the number of dark matter particles would remain (roughly) constant as the Universe continued to expand. Particles with a larger interaction cross section would continue to annihilate for a longer period of time, and thus would have a smaller number density when the annihilation interaction ceases. Based on the current estimated abundance of dark matter in the Universe, if the dark matter particle is such a relic particle, the interaction cross section governing the particle-antiparticle annihilation can be no larger than the cross section for the weak interaction. If this model is correct, the dark matter particle would have the properties of the WIMP. Obtaining the correct abundance of dark matter today via thermal production requires a self-annihilation cross section, which is roughly what is expected for a new particle in the 100 GeV mass range that interacts via the electroweak force. This phenomenon is termed as ‘WIMP miracle’.

Characteristics of WIMP:

- The main theoretical characteristics of a WIMP are:
- Interactions only through the weak nuclear force and gravity,
- Large mass compared to standard particles (sub GeV).

WIMPs would tend to clump together because their relatively low velocities would be insufficient to overcome the mutual gravitational attraction. WIMPs gained popularity in late 1970s and early 1980s when scientists realized that particles naturally popped out in models of super symmetry have the potential to explain the mysterious dark matter. The fact that we find this coincidence of particle properties between the cosmological and astrophysical observations of dark matter on one side and particle physics on the other side is a very compelling motivation to look for direct evidence for WIMPs.

Experiments to detect WIMPs:

There is a Nobel Prize waiting for whoever discovers the dark matter. Because WIMPs may only interact through gravitational and weak forces, they are extremely difficult to detect. However, there are many experiments underway to attempt to detect WIMPs both directly and indirectly.

Indirect detection refers to the observation of annihilation or decay products of WIMPs far away from Earth. Indirect detection typically focuses on locations where WIMP dark matter is thought to accumulate the most: in the centers of galaxies and galaxy clusters, as well as in the dwarf satellite galaxies orbiting the Milky Way. Typical indirect searches look for excess gamma rays, which are predicted both as final-state products of annihilation.

Another type of indirect WIMP signal could come from the Sun. Halo WIMPs may, as they pass through the Sun, interact with solar protons, helium nuclei as well as heavier elements. If a WIMP loses enough energy in such an interaction to fall below the local escape velocity, it would not have enough energy to escape the gravitational pull of the Sun and would remain gravitationally bound. As more and more WIMPs thermalize inside the Sun, they begin to annihilate with each other, forming a variety of particles, including high-energy neutrinos.

These neutrinos may then travel to the Earth to be detected in one of the many neutrino telescopes, such as the Super-Kamiokande detector in Japan. Similar experiments are underway to detect neutrinos from WIMP annihilations within the Earth and from within the galactic center.

Direct detection refers to the observation of the effects of a WIMP-nucleus collision as the dark matter passes through a detector in an Earth laboratory, as well as attempts to directly produce WIMPs in particle colliders such as Large Hadron Collider (LHC).

While most WIMP models indicate that a large enough number of WIMPs must be captured in large celestial bodies for indirect detection experiments to succeed, it remains possible that these models are either incorrect or only explain part of the dark matter phenomenon. Thus, even with the multiple experiments dedicated to providing indirect evidence for the existence of cold dark matter, direct detection measurements are also necessary to solidify the theory of WIMPs. For direct observation, special purpose experiments such as the Cryogenic Dark Matter Search (CDMS) seek to detect the rare impacts of WIMPs in terrestrial detectors. The sensitivity required is phenomenal, and many mundane background events (cosmic rays, natural radioactivity) that might mimic WIMPs must be screened out. For this reason, there is a strong desire to perform these experiments in deep mine shafts where the apparatus can be shielded from the cosmic rays that bombard our planet and other practical nuisances. The general strategy of current attempts to detect WIMPs is to find very sensitive systems that can be scaled up to large volumes. The next decade should see the emergence of several multi-tonne mass direct detection experiments, which will probe WIMP-nucleus cross sections orders of magnitude smaller than the current state-of-the-art sensitivity.

Dark matter hunter Thomas Shutt of Stanford University and SLAC National Accelerator Laboratory is excited about the WIMPs and co founder of Large Underground Xenon (LUX) dark matter experiment in an underground mine in South Dakota. He is also involved in next generation LUX-ZEPLIN (LZ) experiment which will start as a several tonne mass liquid xenon experiment before moving up to twenty tonnes.

According to Tim Tait, Particle Physicist of University of California, Irvine," Most supersymmetric theories estimates the mass of the lightest WIMP to be somewhere above 100 gigaelectronvolts, which is well within Cern's LHC's energy regime." However, recent null results from direct detection experiments along with the failure to produce evidence of supersymmetry in the LHC experiment has cast doubt on the simplest WIMP hypothesis.

Challenge

The intensive, worldwide search for dark matter has so far failed to find strange new weakly interacting particles, but a new candidate is slowly gaining followers and observational support Called SIMPs, strongly interacting massive particles, which were proposed three years ago by University of California, Berkeley theoretical physicist Hitoshi Murayama, a professor of physics and director of the Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU) in Japan.

SIMPs overcome a major failing of WIMP theory: the ability to explain the distribution of dark matter in small galaxies. "There has been this longstanding puzzle: If you look at dwarf galaxies, which are very small with rather few stars, they are really dominated by dark matter. And if you go through numerical simulations of how dark matter clumps together, they always predict that there is a huge concentration towards the center. A cusp," Murayama said. "But observations seem to suggest that concentration is flatter: a core instead of a cusp. The core/cusp problem has been considered one of the major issues with dark matter".

Murayama says that recent observations of a nearby galactic pile-up could be evidence for the existence of SIMPs, and he anticipates that future particle physics experiments will discover one of them.

Conclusion

WIMP's (Weakly Interacting Massive Particles) and such "exotic" particles beyond the Standard Model of physics and the Dark Matter (DM) physics, have strong possibility to exist in nature, there are beautiful symmetries, observations and plausible models which posit various kinds of WIMP's, both heavy and light, but unfortunately so far there is no decisive "unanimously-accepted" evidence of these or other DM particles.

In part this is because it is only since around 2010 that particle accelerators specifically designed to study physics beyond the Standard Model have become operational. The first runs of the LHC found no previously-unknown particles other than the Higgs boson which was already suspected to exist as part of the Standard Model, and therefore no evidence for supersymmetry. These findings disappointed many physicists, who believed that supersymmetry (and other theories relying upon it) was by far the most promising theories for "new" physics, and had hoped for signs of unexpected results from these runs. Former enthusiastic supporter Mikhail Shifman went as far as urging the theoretical community to search for new ideas and accept that supersymmetry was a failed theory. However it has also been argued that the collider energies needed for such a discovery were likely too low, so superpartners could exist but be more massive than the LHC can detect.

At this point we cannot decide which of the discussed candidates makes up the dark matter in our universe, but WIMPs seem for several reasons to be one of the most straight forward explanations. In science, sometimes a physical entity is predicted theoretically, but it may take half a century to experimentally be confirmed. This is happened with Higgs boson. It depends on the particle characters and the available technology of detection. Same thing also happened with gravitational waves. So not detecting WIMP yet does not mean WIMP is not a correct prediction, it is a very weak interacting particle with matter, so its detection is not easy. Of course one day either it will be detected or falsified scientifically. This is the way how science works.

For those who are interested : - brief of particle physics and model of universe.

We know that our present picture of elementary particles and the forces acting between them, the so called Standard Model, is incomplete.

The **Standard Model** of Particle physics is the theory describing three of the four known fundamental forces – the gravitational force in the universe. A separate theory, General Relativity, is used for gravity. According to this model all elementary particles are—depending on their spin—either bosons or fermions. Particles of half integer spin exhibit Fermi–Dirac statistics and are called fermions.Particles of full integer spin exhibit Bose – Einstein statistics and are called bosons. Bosons differ from fermions in the fact that multiple bosons can occupy the same quantum state (Pauli Exclusion Principle).

Fermions are the constituents of all matters. The Standard Model of particle physics contains 24 elementary fermions - 12 particles and their corresponding antiparticles - leptons and quarks and their antiparticles (for example, the antielectron (positron) e^+ is the electron's antiparticle and has an electric charge of +1). There are six leptons, three of which have an electric charge of −1, called the electron, the muon, and the tau, the other three leptons are neutrinos called electron neutrino, muon neutrino and tau neutrino. Neutrinos do not have any charge. The remaining six particles are quarks-up, down, charm, strange, top, bottom.

Bosons are elementary particles that mediate the forces and known as gauge (spin-1) bosons (gluons, photons, and the W and Z bosons). The Standard Model also predicted the existence of a type of boson known as the Higgs boson with spin 0, which is responsible for the intrinsic mass of particles. On 4 July 2012, physicists with the Large Hadron Collider at CERN announced they had found a new particle that behaves similarly to what is expected from the Higgs boson.

In standard model the particles that have little interaction with normal matter, such as neutrinos, are all very light, and hence would be fast moving or "hot" and cannot be dark matter particle.

While explaining the evolution of cosmos, some parameters needed to be added arbitrarily in the standard model which challenged it e.g. hierarchy problem (i.e., why do the elementary particles have the various masses that they do) could not be well explained by standard model. So other models are also proposed by science communities to resolve the shortcoming of standard. Among these models grand unified theory, super symmetry, string theory have gain popularity.

Grand Unified Theory: Initially the Electromagnetic and weak forces were thought to be two separate forces until scientist discovered the electroweak theory to explain both of them as single force – electroweak force. Grand unified theory attempts to combine the electroweak and strong force by a single force where such force breaks into three forces by higgs mechanism (generation of masses for the gauge bosons through electroweak symmetry breaking).

Supersymmetry: This is a theory which proposes relationship between Fermions and bosons. According to this theory, each particle of standard model would have a super partner whose spin differs by 1/2 from the ordinary particle. These super partners are termed by supersmmetric particle abbreviated as sparticles i.e. sleptons, squarks, neutralinos, and charginos etc. Since the superpartners of the Z boson (zino), the photon (photino) and the neutral higgs (higgsino) have the same quantum numbers, they can mix to form four eigenstates of the mass operator called "neutralinos". In many models the lightest of the four neutralinos turns out to be the lightest supersymmetric particle (LSP) which is stable and have the potential to become mysterious dark particle. Supersymmetry extension of standard model can resolve many problem including hierarchy which otherwise remains beyond the scope of standard model.

String theory: In this model, all particles are composed of one dimensional object called strings. These strings vibrate at different frequencies that determine mass, electric charge, spin etc. Some predictions of the string theory include existence of extremely massive counterparts of ordinary particles due to vibrational excitations of the fundamental string and also existence of a massless spin-2 particle behaving like the graviton.

Source: Internet

EARTHING

NAYAN PAUL, 3RD YEAR

To connect the metallic parts of electric machinery and devices to the earth plate or earth electrode (which is buried in the moisture earth) through a thick conductor wire (which has very low resistance) for safety purpose is known as *Earthing or grounding*.Earthing and grounding is the same term used for earthing . grounding is used in north American standards whereas earthing is used in britian standard. In aeroplanes and submarines we connect the metallic parts of electric machinery and devices to common bus bar at refence or 0 potenrial . This is grounding not earthing(means connevcting to earth).

BONDING:- It means connecting different parts of electrical installations which is not considered to carry current under normal conditions together to bring them at same level of electrical potential. It is jointing of two wires or pipes.The primary purpose of earthing is to avoid or minimize the danger of electrocution, fire due to earth leakage of current through undesired path and to ensure that the potential of a current carrying conductor does not rise with respect to the earth than its designed insulation.

Below are the basic needs of Earthing.

- To protect human lives as well as provide safety to electrical devices and appliances from leakage current.
- To keep voltage as constant in the healthy phase that ensures proper working of insulation. (If fault occurs on any one phase).
- To Protect Electric system and buildings form lighting.
- To serve as a return conductor in electric traction system and communication.
- To avoid the risk of fire in electrical installation systems.

Different Terms used in Electrical Earthing

- **Earth:** The proper connection between electrical installation systems via conductor to the buried plate in the earth is known as Earth.
- **Earthed:** When an electrical device, appliance or wiring system connected to the earth through earth electrode, it is known as earthed device or simple "Earthed".

- **Solidly Earthed:** When an electric device, appliance or electrical installation is connected to the earth electrode without a fuse, circuit breaker or resistance/Impedance, It is called "solidly earthed".
- **Earth Electrode:** When a conductor (or conductive plate) buried in the earth for electrical earthing system. It is known to be Earth Electrode. Earth electrodes are in different shapes like, conductive plate, conductive rod, metal water pipe or any other conductor with low resistance.
- **Earthing Lead**: The conductor wire or conductive strip connected between Earth electrode and Electrical installation system and devices in called Earthing lead.
- **Earth Continuity Conductor:** The conductor wire, which is connected among different electrical devices and appliances like, distribution board, different plugs and appliances etc. in other words, the wire between earthing lead and electrical device or appliance is called earth continuity conductor. It may be in the shape of metal pipe (fully or partial), or cable metallic sheath or flexible wire.
- **Sub Main Earthing Conductor**: A wire connected between switch board and distribution board i.e. that conductor is related to sub main circuits.
- **Earth Resistance:** This is the total resistance between earth electrode and earth in Ω (Ohms). Earth resistance is the algebraic sum of the resistances of earth continuity conductor, earthing lead, earth electrode and earth.

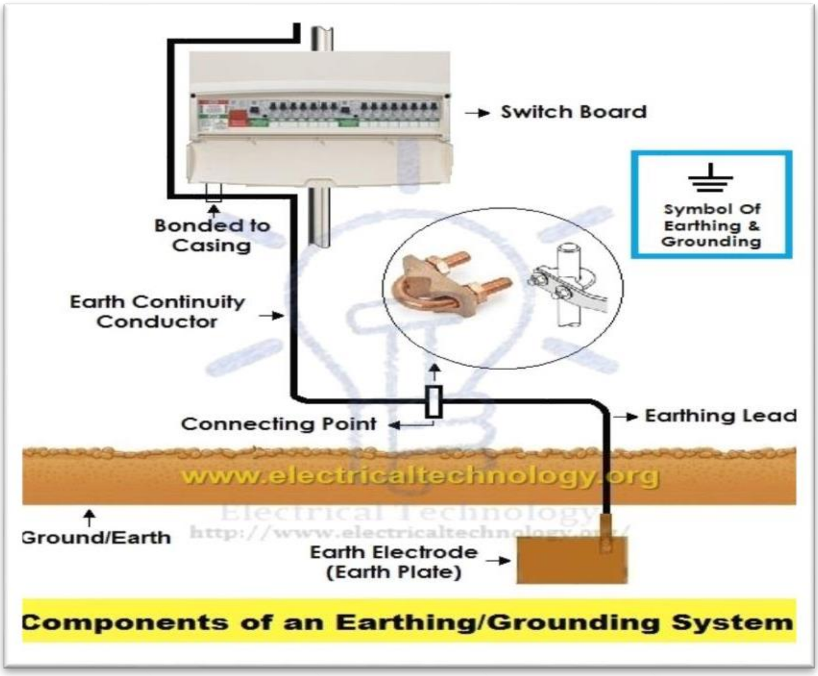
POINTS TO BE EARTHED

- Earthing is not done anyhow. According to IE rules and IEE (Institute of Electrical Engineers) regulations,
- Earth pin of 3-pin lighting plug sockets and 4-pin power plug should be efficiently and permanently earthed.
- All metal casing or metallic coverings containing or protecting any electric supply line or apparatus such as GI pipes and conduits enclosing VIR or PVC cables, iron clad switches, iron clad distribution fuse boards etc should be earthed (connected to earth).
- The frame of every generator, stationary motors and metallic parts of all transformers used for controlling energy should be earthed by two separate and yet distinct connections with the earth.
- In a dc 3-wire system, the middle conductors should be earthed at the generating station.
- Stay wires that are for overhead lines should be connected to earth by connecting at least one strand to the earth wires.

Components of Earthing System

A complete electrical earthing system consists on the following basic components.

- Earth Continuity Conductor
- Earthing Lead
- Earth Electrode



Earth Continuity Conductor or Earth Wire :

That part of the earthing system which interconnects the overall metallic parts of electrical installation e.g. conduit, ducts, boxes, metallic shells of the switches, distribution boards, Switches, fuses, Regulating and controlling devices, metallic parts of electrical machines such as, motors, generators, transformers and the metallic framework where electrical devices and components are installed is known as earth wire or earth continuity conductor as shown in the above fig.According to IEEE rules, resistance between consumer earth terminal and earth Continuity conductor (at the end) should not be increased than 1Ω.

Size of Earth Continuity Conductor

The cross sectional area of the **Earth Continuity Conductor** should not be less than the half of the cross sectional area of the thickest wire used in the electrical wiring installation.

Generally, the size of the bare copper wire used as earth continuity conductor is 3SWG(standard wire gauge). But keep in mind that, don't use less than 14SWG as earth wire.

Earthing Lead or Earthing Joint

The conductor wire connected between earth continuity conductor and earth electrode or earth plate is called earthing joint or "Earthing lead". The point where earth continuity conductor and earth electrode meet is known as "connecting point" as shown in the above figure.

There should be minimum joints in earthing lead as well as lower in size and straight in the direction

Generally, copper wire can be used as earthing lead but, copper strip is also used for high installation and it can handle the high fault current because of wider area than the copper wire. Galvnized Iron(GI) strips may also be used.

To increase the safety factor of installation, generally DG, transformer, motor etc two copper wires are used as earthing lead to connect the device metallic body to the earth electrode or earth plate. I.e. if we use two earth electrodes or earth plats, there would be four earthing leads. It should not be considered that the two earth leads are used as parallel paths to flow the fault currents but both paths should work properly to carry the fault current because it is important for better safety.

Earth Plate :-The final underground metallic (plate) part of the earthing system which is connected with earthing lead is called earth plate or earth electrode.

A metallic plate, pipe or rode can be used as an earth electrode which has very low resistance and carry the fault current safely towards ground (earth).

The size of earth electrode (In case of copper)

2×2 (two foot wide as well as in length) and 1/8 inch thickness.. I.e. 2' x 2' x 1/8". (600x600x300 mm)

In case of Iron

2' x2' x ¼" = 600x600x6 mm

It is recommended to bury the earth electrode in the moisture earth. If it is not possible, then put water in the GI (Galvanized Iron) pipe to make possible the moisture condition.

Also, put a 1 foot (about 30cm) **layer of powdered charcoal and lime mixture** around the earth plate.This action makes the possible increase in the size of the earth electrode which leads a better continuity in the earth (earthing system) and also helps to maintain the moisture condition around earth plate. Since, the water level is different in the different areas; therefore, the depth for earth electrode installation is also different in various areas. But, the depth for earth electrode installation should not be less than 10ft (3 meter) and should below 1 foot (304.8mm) from the constant water level.

Motors, **Generator**, **Transformers** etc should be connected from to earth electrode two different places.

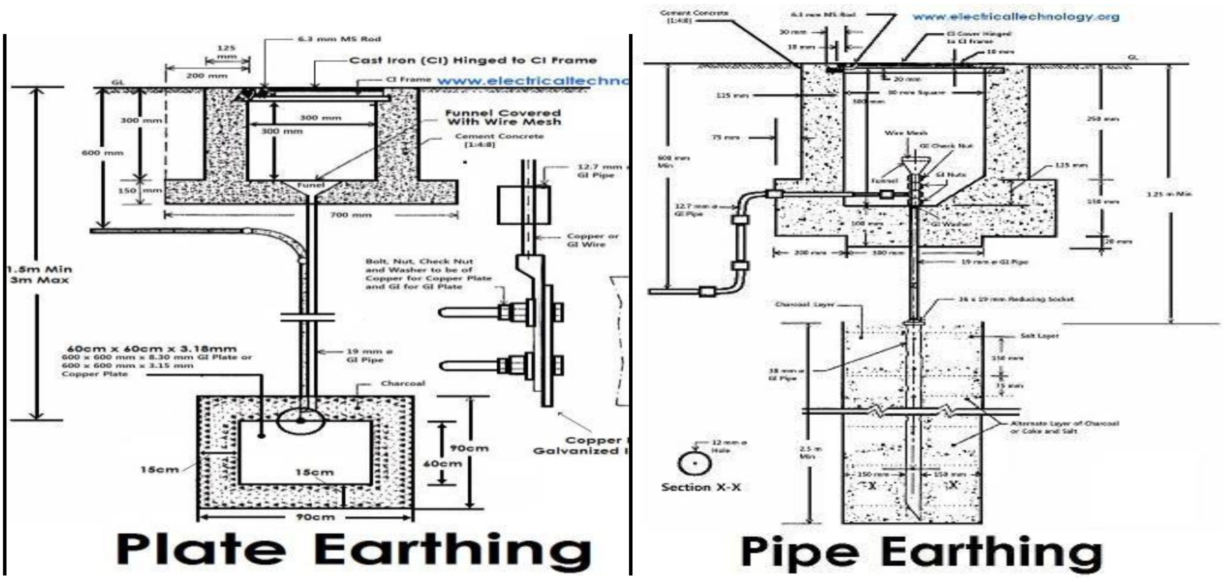
Earthing Electrode:-

In small installation, use metallic rod (diameter = 25mm (1inch) and length = 2m (6ft) instead of earth plate for earthing system. The metallic pipe should be 2 meter below from the surface of ground. To maintain the moister condition, put 25mm (1inch) coal and lime mixture around the earth plate.

For effectiveness and convenience, you may use the copper rods 12.5mm (0.5 inch) to 25mm (1 inch) diameter and 4m (12ft) length.

Methods of Earthing | Types of Earthing

1). Plate Earthing: In plate earthing system, a plate made up of either copper with dimensions 60cm x 60cm x 3.18mm (i.e. 2ft x 2ft x 1/8 in) or galvanized iron (GI) of dimensions 60cm x 60cm x 6.35 mm (2ft x 2ft x ¼ in) is buried vertical in the earth (earth pit) which should not be less than 3m (10ft) from the ground level.



2) Pipe Earthing:

A galvanized steel and a perforated pipe of approved length and diameter is placed vertically in a wet soil in this kind of system of earthing. It is the most common system of earthing.

The size of pipe to use depends on the magnitude of current and the type of soil. The dimension of the pipe is usually 40mm (1.5in) in diameter and 2.75m (9ft) in length for ordinary soil or greater

3). Rod Earthing:- it is the same method as pipe earthing. A copper rod of 12.5mm (1/2 inch) diameter or 16mm (0.6in) diameter of galvanized steel or hollow section 25mm (1inch) of GI pipe of length above 2.5m (8.2 ft) are buried upright in the earth manually or with the help of a pneumatic hammer. The length of embedded electrodes in the soil reduces earth resistance to a desired value.

4). Earthing through the Waterman

In this method of earthing, the waterman (Galvanized GI) pipes are used for earthing purpose. Make sure to check the resistance of GI pipes and use earthing clamps to minimize the resistance for proper earthing connection.

5). Strip or Wire Earthing:

In this method of earthing, strip electrodes of cross-section not less than 25mm x 1.6mm (1in x 0.06in) is buried in a horizontal trenches of a minimum depth of 0.5m. If copper with a cross-section of 25mm x 4mm (1in x 0.15in) is used and a dimension of 3.0mm^2 if it's a galvanized iron or steel.

SI specification for Earthing

Various specifications in respect to earthing as recommended by Indian Standards are given below. Here are few;

- An earthing electrode should not be situated (installed) close to the building whose installation system is being earthed at least more than 1.5m away.
- The earth resistance should be low enough to cause the flow of current sufficient to operate the protective relays or blow fuses. It's value is not constant as it varies with weather because it depends on moisture (but should not be less than 1 Ohm).
- The earth wire and earth electrode will be the same material.
- The earthing electrode should always be placed in a vertical position inside the earth or pit so that it may be in contact with all the different earth layers.

General method of Earthing / Proper Grounding Installation (Step by Step)

The usual method of earthing of electric equipments, devices and appliances are as follow:

- First of all, dig a 5x5ft (1.5×1.5m) pit about 20-30ft (6-9 meters) in the ground. (Note that, depth and width depends on the nature and structure of the ground)
- Bury an appropriate (usually 2' x 2' x 1/8" (600x600x300 mm) copper plate in that pit in vertical position.
- Tight earth lead through nut bolts from two different places on earth plate.
- Use two earth leads with each earth plate (in case of two earth plates) and tight them.
- To protect the joints from corrosion, put grease around it.
- The earth pits are interconnected throught the earth leads i.e strips (in ring type system) and tappings to building from different points as required are taken. This leads are taken to ground floor, run along the wall to first , second and wherever needed. Their these are directly connected to high loads . For low loads they are connected to either through earth continuity conductor via connecting point or directly to the earth point of the switch box. This point is internally connected to earth link (refer the diagram of distribution board). From earth link earth wires run through conduits to the equipments to be earthed. A separate earth lid as per IS should run along the building to separate earth pit as per IS.
- To maintain the moisture condition around the earth plate, put a 1ft (30cm) layer of powdered charcoal (powdered wood coal) and lime mixture around the earth plate of around the earth plate.
- Use thimble and nut bolts to connect tightly wires to the bed plates of machines. Each machine should be earthed from two different places. The minimum distance between two earth electrodes should be 10 ft (3m).
- Earth continuity conductor which is connected to the body and metallic parts of all installation should be tightly connected to earth lead.
- At last (but not least), test the overall earthing system through earth tester. If everything is going about the planning, then fill the pit with soil. The maximum allowable resistance for earthing is 1Ω. If it is more than 1 ohm, then increase the size (not length) of earth lead and earth continuity conductors. Keep the external ends of the pipes open and put the water time to time to maintain the moisture condition around the earth electrode which is important for the better earthing system

Classification of Systems Based on Types of System Earthing

Internationally, it has been agreed to classify the earthing systems as TN System. TT System and iT System. They are:

a) TN svstem - has one or more points of the source of energy directly earthed, and the exposed and extraneous conductive parts of the installation are connected by means of protective conductors to the earthed point(s) of the source, that is, there is a metallic path for earth fault currents to flow from the installation to the earthed point(s) of the source. TN systems are further sub-divided into TN-C, TN-S and TN -C-S systems.

b) TT ,\ystem -- has one or more points of the source of energy directly earthed and the exposed and extraneous conducti ve parts of the installation are connec ted to a local earth electrode or electrodes are electrically independent of the source earth(s).

c) IT system - has the source either unearthed or earthed through a high impedance and the exposed conductive parts of the installation are connected to electrically independent earth electrodes.

It is also recognized that, in practice, a system may be an admixture of type for the purposes of this code, earthing systems are designated as follows:

a) TN-S System (for 240 V single phase domestic! commercial supply) - Systems where there are separate neutral and protective conductors throughout the system. A system where the metallic path between the installation and the source of energy is the sheath and armouring of the supply cable .

b) Indian TN-S System (for 415 V three-phase domestic commercial supp~v) – An independent earth electrode within the consumer's premises is necessary

c) Indian TN C-System - The neutral and protective functons are combined in a singlecouductor throughout the system (for example earthed concentric wiring).

d) TN-C-S S.vstem - The neutral and protective functions are combined in a single conductor but only in part of the system

e) T-TN-S s.ystem (for 6-6111 kV three-phase bulk SlIPPZV) - The consumers installation, a TN -S system receiving power at a captive substation through a delta connected transformer primary.

For figure and other details visit page 12 of IS 3043.

HOW TO CHOSE THE NUMBER OF EARTHING ELECTRODES??

Number of Earthing Electrode and Earthing Resistance depends on the **resistivity of soil** and time for fault current to pass through (1 sec or 3 sec). There is no general rule to calculate the exact number of earth pits and size of earthing strip, but **discharging of leakage current** is certainly dependent on the cross section area of the material so for any equipment **the earth strip size is calculated on the current to be carried by that strip**.First the **leakage current** to be carried is calculated and then size of the strip is determined.

The earth resistance of single rod or pipe electrode is calculated as per **BS 7430**:

R=ρ/2×3.14xL (loge (8xL/d)-1)

Where:

ρ = *Resistivity of soil (Ω meter),*
L = *Length of electrode (meter),*
D = *Diameter of electrode (meter)*

B. Earthing resistance and number of rods for isolated earth pit (with buried earthing strip)

Resistance of earth strip (R) As per **IS 3043**:

R=ρ/2×3.14xLx (loge (2xLxL/wt))

Methods of Neutral Earthing

There are five methods for Neutral earthing:

- Unearthed Neutral System
- Solid Neutral Earthed System
- Resistance Neutral Earthing System
    - Low Resistance Earthing
    - High Resistance Earthing
- Resonant Neutral Earthing System
- Earthing Transformer Earthing

1)UNGROUNDED SYSTEM:-

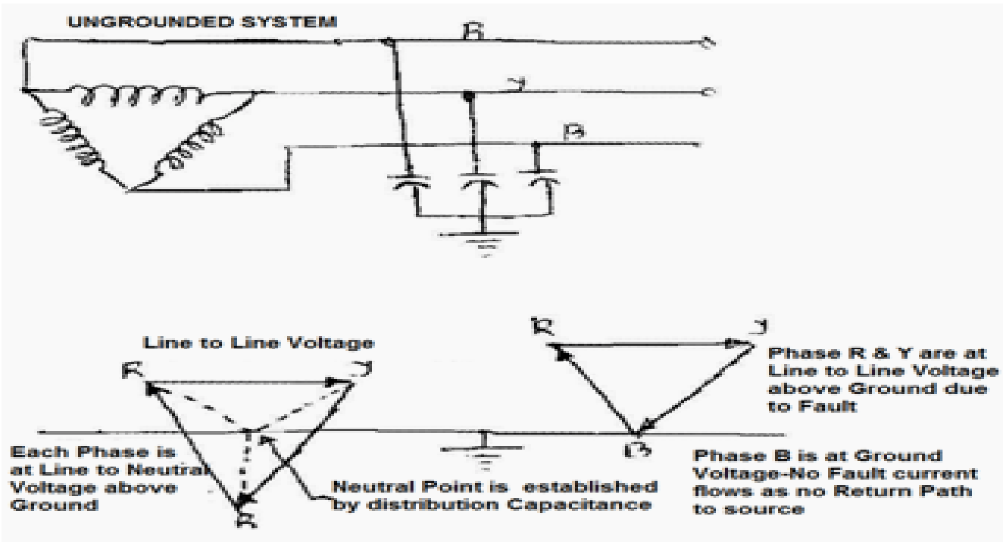
In ungrounded system there is no internal connection between the conductors and earth. However, as system, a capacitive coupling exists between

the system conductors and the adjacent grounded surfaces. Consequently, the "ungrounded system" is, in reality, a "capacitive grounded system" by virtue of the distributed capacitance.

Under normal operating conditions, this distributed capacitance causes no problems. In fact, it is beneficial because it establishes, in effect, a neutral point for the system; As a result, the phase conductors are stressed at only line-to-neutral voltage above ground.

But problems can rise in ground fault conditions. A ground fault on one line results in full line-to-line voltage appearing throughout the system. Thus, a voltage 1.73 times the normal voltage is present on all insulation in the system.

This situation can often cause failures in older motors and transformers, due to insulation breakdown.



Advantages

- After the first ground fault, assuming it remains as a single fault, the circuit may continue in operation, permitting continued production until a convenient shut down for maintenance can be scheduled.

Disadvantages

- The interaction between the faulted system and its distributed capacitance may cause transient over-voltages (several times normal) to appear from line to ground during normal switching of a circuit having a line-to ground fault (short). These over voltages may cause insulation failures at points other than the original fault.
- A second fault on another phase may occur before the first fault can be cleared. This can result in very high line-to-line fault currents, equipment damage and disruption of both circuits.
- The cost of equipment damage.

- Complicate for locating fault(s), involving a tedious process of trial and error: first isolating the correct feeder, then the branch, and finally, the equipment at fault. The result is unnecessarily lengthy and expensive down downtime.

2. Solidly Neutral Grounded Systems

Solidly grounded systems are usually used in low voltage applications at 600 volts or less. In solidly grounded system, the neutral point is connected to earth.Solidly Neutral Grounding slightly reduces the problem of transient over voltages found on the ungrounded system and provided path for the ground fault current is in the range of ***25 to 100% of the system three phase fault current.***.However, if the reactance of the generator or transformer is too great, the problem of transient over voltages will not be solved.While solidly grounded systems are an improvement over ungrounded systems, and speed up the location of faults, they lack the current limiting ability of resistance grounding and the extra protection this provides. Its purpose is to maintain very low impedance to ground faults so that a relatively high fault current will flow thus insuring that circuit breakers orfuseswill clear the fault quickly and therefore minimize damage

It also greatly reduces the shock hazard to personnel.If the system is not solidly grounded, the neutral point of the system would "float" with respect to ground as a function of load subjecting the line-to-neutral loads to voltage unbalances and instability.

Advantages

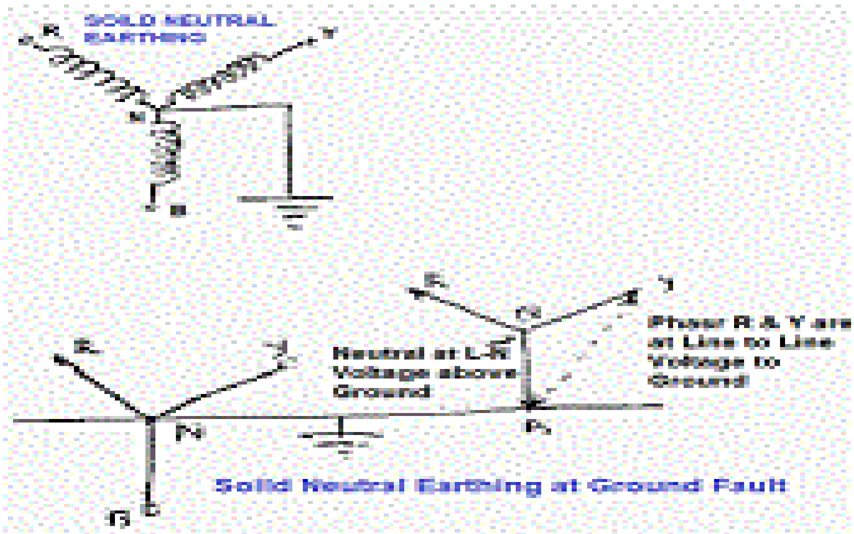
- The main advantage of solidly earthed systems is low over voltages, which makes the earthing design common at high voltage levels (HV).

Disadvantages

- This system involves all the drawbacks and hazards of high earth fault current: maximum damage and disturbances.
- There is no service continuity on the faulty feeder.
- The danger for personnel is high during the fault since the touch voltages created are high.

Applications

- Distributed neutral conductor
- 3-phase + neutral distribution
- Use of the neutral conductor as a protective conductor with systematic earthing at each transmission pole
- Used when the short-circuit power of the source is low.



3) Resistance earthed system:

Resistance grounding has been used in three-phase industrial applications for many years and it resolves many of the problems associated with solidly grounded and ungrounded systems. Resistance Grounding Systems limits the phase-to-ground **fault currents**.

The main reasons for limiting the phase to ground fault current by resistance grounding are:

- To reduce burning and melting effects in faulted electrical equipment like switchgear, transformers, cables, and rotating machines.
- To reduce **mechanical stresses** in circuits/Equipments carrying fault currents.
- To reduce electrical-shock hazards to personnel caused by stray ground fault.
- To reduce the arc blast or flash hazard.
- To reduce the momentary line-voltage dip.
- To secure control of the transient over-voltages while at the same time.
- To improve the detection of the earth fault in a power system.

Grounding Resistors are generally connected between ground and neutral of transformers, generators and grounding transformers ***to limit maximum fault current as per Ohms Law to a value which will not damage the equipment*** in the power system and allow sufficient flow of fault current to detect and operate Earth protective relays to clear the fault. Although it is possible to limit fault currents with high resistance Neutral grounding Resistors, earth short circuit currents can be extremely reduced.

As a result of this fact, protection devices may not sense the fault.

Therefore, it is the most common application to limit single phase fault currents with low resistance Neutral Grounding Resistors to approximately rated current of transformer and / or generator.

In addition, limiting fault currents to predetermined maximum values permits the designer to selectively coordinate the operation of protective devices, which minimizes system disruption and allows for quick location of the fault.

There are two categories of resistance grounding:

- Low resistance Grounding
- High resistance Grounding

Ground fault current flowing through either type of **resistor** when a single phase faults to ground will increase the phase-to-ground voltage of the remaining two phases. As a result, ***conductor insulation and surge arrestor ratings must be based on line-to-line voltage***. This temporary increase in phase-to-ground voltage should also be considered when selecting two and three pole breakers installed on resistance grounded low voltage systems

If line-to neutral loads (such as 277V lighting) are present, they must be served by a solidly grounded system. This can be achieved with an isolation transformer that has a three-phase delta primary and a three-phase, four-wire, wye secondary.

Neither of these grounding systems (low or high resistance) reduces arc-flash hazards associated with phase-to-phase faults, but both systems significantly reduce or essentially eliminate the arc-flash hazards associated with phase-to-ground faults. Both types of grounding systems limit mechanical stresses and reduce thermal damage to electrical equipment, circuits, and apparatus carrying faulted current.

Generally speaking high-resistance grounding refers to a system in which the NGR let-through current is less **than 50 to 100 A.**Low resistance grounding indicates that NGR current would be **above 100 A.**

A better distinction between the two levels might be alarm only and tripping. An alarm-only system continues to operate with a single ground fault on the system for an unspecified amount of time. In a tripping system a ground fault is automatically removed by protective relaying and circuit interrupting devices. Alarm-only systems usually limit NGR current to 10 A or less.

Rating of The Neutral grounding resistor:

Voltage: Line-to-neutral voltage of the system to which it is connected.

Initial Current: The initial current which will flow through the resistor with rated voltage applied.

Time: The “on time” for which the resistor can operate without exceeding the allowable temperature rise.

A. Low Resistance Grounded

Low Resistance Grounding is used for large electrical systems where there is a high investment in capital equipment or prolonged loss of service of equipment has a significant economic impact and it is not commonly used in low voltage systems because the limited ground fault current is too low to reliably operate breaker trip units or fuses. This makes system selectivity hard to achieve. Moreover, low resistance grounded systems are not suitable for 4-wire loads and hence have not been used in commercial market applications. A resistor is connected from the system neutral point to ground and generally sized to permit only ***200A to 1200 amps*** of ground fault current to flow. Enough current must flow such that protective devices can detect the faulted circuit and trip it off-line but not so much current as to create major damage at the fault point.

Since the grounding impedance is in the form of resistance, any transient over voltages are quickly damped out and the whole transient overvoltage phenomena is no longer applicable. Although theoretically possible to be applied in low voltage systems (e.g. 480V),significant amount of the system voltage dropped across the grounding resistor, there is not enough voltage across the arc forcing current to flow, for the fault to be reliably detected.

For this reason low resistance grounding is not used for low voltage systems (under 1000 volts line to-line).

Advantages

- Limits phase-to-ground currents to 200-400A.
- Reduces arcing current and, to some extent, limits arc-flash hazards associated with phase-to-ground arcing current conditions only.
- May limit the mechanical damage and thermal damage to shorted transformer and rotating machinery windings.

Disadvantages:

- Does not prevent operation of over current devices.
- Does not require a ground fault detection system.
- May be utilized on medium or high voltage systems.
- Conductor insulation and surge arrestors must be rated based on the line to-line voltage. Phase-to-neutral loads must be served through an isolation transformer.
- Used: Up to 400 amps for 10 sec are commonly found on medium voltage systems.

B. High Resistance Grounded

High resistance grounding is almost identical to low resistance grounding except that the ground fault current magnitude is typically limited to ***10 amperes or less***. High resistance grounding accomplishes two things.

The first is that the ***ground fault current magnitude is sufficiently low enough such*** that no appreciable damage is done at the fault point. This means that the faulted circuit need not be tripped off-line when the fault first occurs.

Under earth fault conditions, the resistance must dominate over the system charging capacitance but not to the point of permitting excessive current to flow and thereby excluding continuous operation.

HRG's are continuous current rated, so the description of a particular unit does not include a time rating. Unlike NGR's, ground fault current flowing through a HRG is usually not of significant magnitude to result in the operation of an over current device. Since the ground fault current is not interrupted, a ground fault detection system must be installed.

These systems include a bypass contactor tapped across a portion of the resistor that pulses (periodically opens and closes). When the contactor is open, ground fault current flows through the entire resistor. When the contactor is closed a portion of the resistor is bypassed resulting in slightly lower resistance and slightly higher ground fault current.

To avoid transient over-voltages, an HRG resistor must be sized so that the amount of ground fault current the unit will allow to flow exceeds the electrical system's charging current. As a rule of thumb, charging current is estimated at 1A per 2000KVA of system capacity for low voltage systems and 2A per 2000KVA of system capacity at 4.16kV.

These estimated charging currents increase if surge suppressors are present. Each set of suppressors installed on a low voltage system results in approximately 0.5A of additional charging current and each set of suppressors installed on a 4.16kV system adds 1.5A of additional charging current.

A system with 3000KVA of capacity at 480 volts would have an estimated charging current of 1.5A.Add one set of surge suppressors and the total charging current increases by 0.5A to 2.0A. A standard 5A resistor could be used on this system. Most resistor manufacturers publish detailed estimation tables that can be used to more closely estimate an electrical system's charging current.

Advantages

1)Enables high impedance fault detection in systems with weak capacitive connection to

2)Some phase-to-earth faults are self-cleared.

3) The neutral point resistance can be chosen to limit the possible over voltage transients to 2.5 times the fundamental frequency maximum voltage.

4) Limits phase-to-ground currents to 5-10A.

5) Reduces arcing current and essentially eliminates arc-flash hazards associated with phase-to-ground arcing current conditions only.

6) Will eliminate the mechanical damage and may limit thermal damage to shorted transformer and rotating machinery windings.

7) Prevents operation of over current devices until the fault can be located (when only one phase faults to ground).

8) May be utilized on low voltage systems or medium voltage systems up to 5kV. IEEE Standard 141-1993 states that "high resistance grounding should be restricted to 5kV class or lower systems with charging currents of about 5.5A or less and should not be attempted on 15kV systems, unless proper grounding relaying is employed".

9) Conductor insulation and surge arrestors must be rated based on the line to-line voltage. Phase-to-neutral loads must be served through an isolation transformer.

Disadvantages
1. Generates extensive earth fault currents when combined with strong or moderate capacitive connection to earth Cost involved.

2. Requires a ground fault detection system to notify the facility engineer that a ground fault condition has occurred.

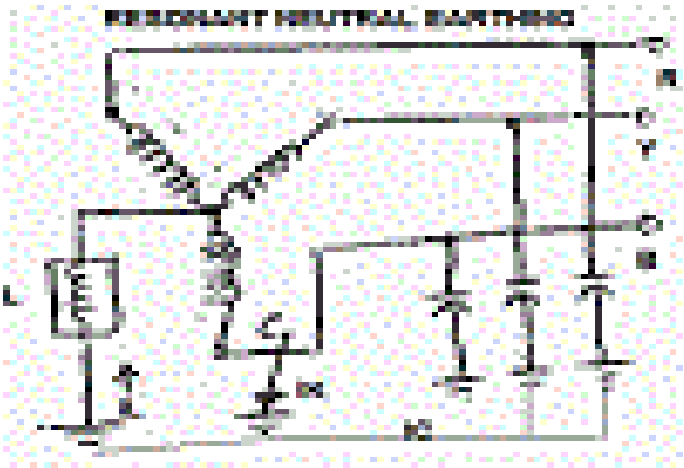
4) Resonant earthed system:

Adding inductive reactance from the system neutral point to ground is an easy method of limiting the available ground fault from something near the maximum 3 phase short circuit capacity (thousands of amperes) to a relatively low value (200 to 800 amperes).To limit the reactive part of the earth fault current in a power system a neutral point reactor can be connected between the transformer neutral and the station earthing system.

A system in which at least one of the neutrals is connected to earth through an

1. Inductive reactance.
2. Petersen coil / Arc Suppression Coil / Earth Fault Neutralizer.

The current generated by the reactance during an earth fault approximately compensates the capacitive component of the single phase earth fault current, is called a resonant earthed system.The system is hardly ever exactly tuned, i.e. the reactive current does not exactly equal the capacitive earth fault current of the system.A system in which the inductive current is slightly larger than the capacitive earth fault current is over compensated. A system in which the induced earth fault current is slightly smaller than the capacitive earth fault current is under compensated



Resonant neutral earthing

However, experience indicated that this inductive reactance to ground resonates with the system shunt capacitance to ground under arcing ground fault conditions and creates very high transient over voltages on the system. To control the transient over voltages, the design must permit at least 60% of the 3 phase short circuit current to flow underground fault conditions.

Petersen Coils

A Petersen Coil is connected between the neutral point of the system and earth, and is rated so that the capacitive current in the ***earth fault is compensated by an inductive current passed by the Petersen Coil***. A small residual current will remain, but this is so small that any arc between the faulted phase and earth will not be maintained and the fault will extinguish. Minor earth faults such as a broken pin insulator, could be held on the system without the supply being interrupted. Transient faults would not result in supply interruptions.

Although the standard ‘Peterson coil’ does not compensate the entire earth fault current in a network due to the presence of resistive losses in the lines and coil, it is now possible to apply ‘residual current compensation’ by injecting an additional 180° out of phase current into the neutral via the Peterson coil. The fault current is thereby reduced to practically zero. Such systems are known as ‘Resonant earthing with residual compensation’, and can be considered as a special case of reactive earthing.

Resonant earthing can reduce EPR to a safe level. This is because the Petersen coil can often effectively act as a high impedance NER, which will substantially reduce any earth fault currents, and hence also any corresponding EPR hazards (e.g. touch voltages, step voltages and transferred voltages, including any EPR hazards impressed onto nearby telecommunication networks).

Advantages

1) Small reactive earth fault current independent of the phase to earth capacitance of the system.
2) Enables high impedance fault detection.

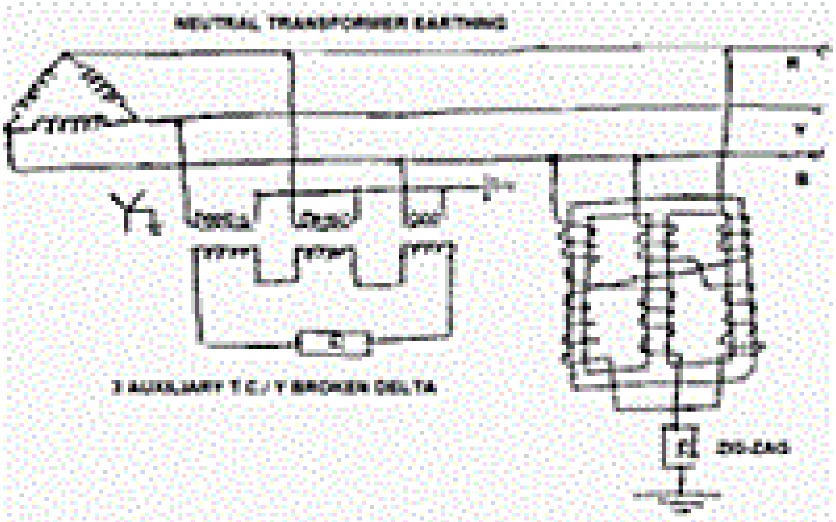
Disadvantages

1) Risk of extensive active earth fault losses.

2) High costs associated

5) Earthing transformer:-

For cases where there is no neutral point available for Neutral Earthing (e.g. for a delta winding), an earthing transformer may be used to provide a return path for single phase faut currents. In such cases the impedance of the earthing transformer may be sufficient to act as effective earthing impedance. Additional impedance can be added in series if required. A special 'zig-zag' transformer is sometimes used for earthing delta windings to provide a low zero-sequence impedance and high positive and negative sequence impedance to fault currents.



EARTHING TRANSFORMER

Comparison of Neutral Earthing System

Condition	**Un grounded**	**Solid Grounded**	**Low Resistance Grounded**	**High Resistance Grounded**	**Reactance Grounding**
Immunity to Transient Over voltages	Worse	Good	Good	Best	Best
73% Increase in Voltage Stress Under Line-to-Ground Fault Condition	Poor	Best	Good	Poor	
Equipment Protected	Worse	Poor	Better	Best	Best
Safety to Personnel	Worse	Better	Good	Best	Best
Service Reliability	Worse	Good	Better	Best	Best
Maintenance Cost	Worse	Good	Better	Best	Best
Ease of Locating First Ground Fault	Worse	Good	Better	Best	Best
Permits Designer to CoordinateProtective	Not Possible	Good	Better	Best	Best

Devices					
Reduction in Frequency of Faults	Worse	Better	Good	Best	Best
Lighting Arrestor	Ungroundedneutral type	Grounded-neutraltype	Ungroundedneutral type	Ungroundedneutral type	Ungroundedneutral type
Current for phase-to ground fault in percent ofthree-phase fault current	Less than 1%	Varies, may be 100% or greater	5 to 20%	Less than 5%	

The commonly used earthing around us:-

GRID EARTHING.

First, Main earth grid is constructed for the entire substation and it is buried 1 to 1.5 meter below the fixed ground level.Main earth grid is nothing but a interconnection of earth rods. It might looks like a mesh. The spacing of this grid is designed to produce a voltage gradient across the surface of the earth that is less than the minimum voltage that can be perceived by a typical person either across the length of a stride (called the 'step potential") or between where that person is standing and a metallic structure that is bonded to that subsurface grid (called the **'reach potential'**). **Transfomers body earth are connected to this main earth gridTransformers neutral are connected to NGR and this NGR is connected to separate treated earth pit and it should be separated from the main earth grid.**Other equipments PT, CT, isolator,etc.are connected to this main earth grid**. Lightning arresters are connected to separate treated earth pits.** The other component is a connection between that metal grid and true earth. True earth is a fictitious equivalent conductor deep beneath the surface of the earth. The design of that connection is typically expressed in ohms - for example, in major facilities, the specification often calls for a 0.5 ohm ground to true earth. Practically, this connection is most often achieved by driving rods into the earth and then bonding those rods to the copper ground grid. The number and length of rods can be varied to achieve the desired degree of grounding.It is normally done in switchyards and substations.

RING GROUND SYSTEM

A **ring ground** is a type of electrical ground that is used to protect buildings and equipment from damage due to electrical surges. Ring grounds are typically used as protection against lightning strikes. They are also known as **ground rings.** They are called type B protection and are used to protect complicated building structures. In normal buildings a single earth electrode normally called type A protection is used. A ring ground is typically constructed from a fairly large wire that is buried at least a few feet underground. The ring ground will usually encircle the entire building at a distance of about 1 to 1.5m depending upon any concrete or something like that present there, that it is trying to protect. The ring ground is used as the base of the entire building's ground system, and all components of the building's ground system, including the building structure, are connected to the ground ring Ring grounds are very commonly used around communications equipment such as cell phone towers, police radio towers, and other types of radio towers and equipment buildings. They

are also often used to protect computer data centers.

HALO GROUND SYSTEM

A **halo ground** is a type of ring ground that, instead of being installed outside and underground, is installed inside, near the top of a building or structure. The ground reference for all equipment inside the area being protected is separate from the halo. The halo is connected to the main building ground, which may include an underground ring ground outside the building, with vertical conductors especially in the corners of the building. Electrical equipment is also often placed in fully enclosed metal cabinets, which function as Faraday cageso further protect the equipment. The halo may be connected to structural metallic elements such as door frames, building steel, window frames, and air conditioning vents.

Theory of Operation

When lightning strikes a metal tower or strikes near a building containing electrical equipment, a large, rapidly changing magnetic field is generated. This magnetic field induces current onto power lines, often disrupting electrical service, and also induces current into other electrical conductors such as electrical equipment and even structural metal used in construction, such as rebar used to reinforce concrete. These induced currents can easily damage electronic equipment.

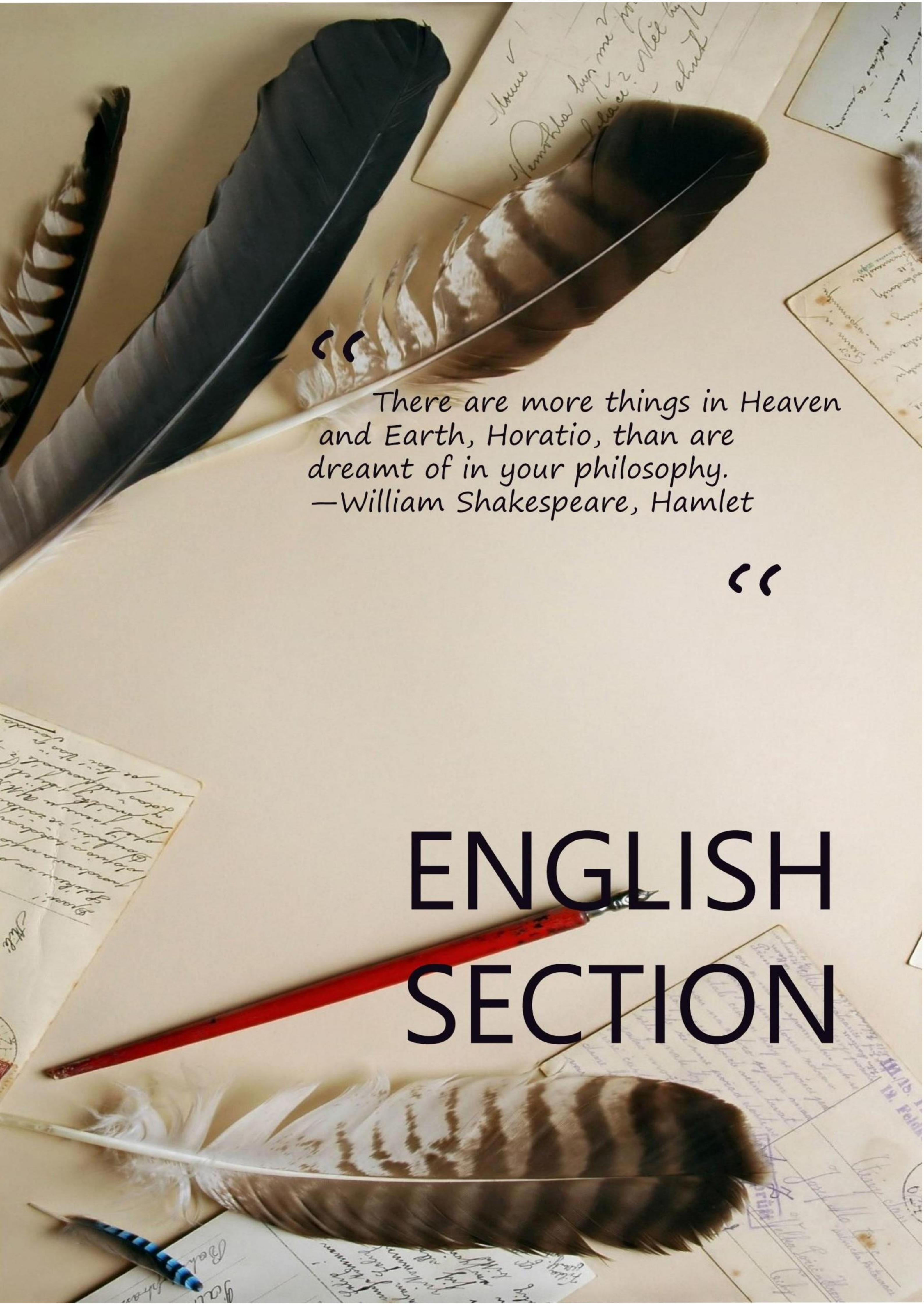
Halo grounds and ring grounds are placed around the areas to be protected so that the magnetic field will encounter these conductors first. Energy from the magnetic field creates currents in the halo and ring ground, and this current is then safely shunted into the earth so that it does not harm equipment inside the protected building. Since most of the energy in the magnetic field is used up in the creation of these currents, very little energy is left over to create damaging currents inside the protected building.

SPIRAL EARTHING

Spiral earthing is mainly done for overhead transmission line. Here a coil is spiralled and connected to ground . Spiralling is mainly done to increase the surface area of contact to reduce the effective resistance.

REFERENCE:-

IEEE Standard 141-1993, “Recommended Practice for Electrical Power Distribution for Industrial Plants”



“ There are more things in Heaven and Earth, Horatio, than are dreamt of in your philosophy.
—William Shakespeare, Hamlet ”

ENGLISH SECTION

> *"The human race has only one really active weapon, and that's laughter"*
>
> *-Mark Twain*

Laughter

DR. SUMITA DEB,
ASSISTANT PROFESOR

As stated by the legendary comedian, Charlie Chaplin, "A day without laughter is a day wasted". Indeed! Just think about the world around you with all the gloomy faces with no signs of smile and laughter. I just cannot imagine it at all! Laughter is definitely an indispensable part of our life and hence Mark Twain pointed out "The human race has only one really active weapon, and that's laughter". So what is this laughter and why do we laugh? Let us now ponder about some very interesting facts about this laughter.

Laughter is a complex process of our body which involves complicated activities of our brain. It is a physical reaction consisting of rhythmical, often audible contractions of the diaphragm and other parts of the respiratory system. it is a full-on collaboration between mind and body. and is a response to certain external or internal stimuli [1]. Laughter is considered to be the most contagious of all emotional experiences. In this regard, one can recall the bizarre event of the 1962 outbreak of contagious laughter in Tanganyika. What began as an isolated fit of laughter in a group of 12 to 18 years old school girls rapidly spread to epidemic proportions, contagious laughter started propagating from one individual to the next, eventually infecting adjacent communities. The epidemic was so severe that it required closing of the schools and lasted as long as six months [2]. Although laughter is one of the distinguishing features of human beings, little is known about the mechanisms behind it. According to *Relief theory* [3], we need a release of our emotions through our laugh. The *Incongruity theory* explains that we laugh when our logic does not match with a situation or a joke. This is, in fact, the basic principle of a comedian. When a comedian delivers a joke, the audience tries to understand the same and when they realize that the inconsistency of the joke mismatches with their own logical expectations, it makes them laugh at the end. Again according to *Superior theory*, whenever we consider ourselves superior to someone else, we laugh at their ignorance and mistakes. It is worth mentioning here that age, gender, culture, education and knowledge level of a person determine the causes and extent of one's laughter. Small children learn to laugh before they can talk or judge situations properly. In fact, human laughter begins at an early age (typically 14 to 16 weeks after birth), often during the interaction between a mother and the infant. Laughter, smiles and other gestures by the baby reinforce the mother's behavior (for example, tickling) and regulate the duration and intensity of the interaction. As suggested by R. Provine, laughter is an ancient form of social signaling that is more akin to animal calls or bird songs than human speech. Although laughter appears in human babies during their infancy, very little is known about the details of the developmental process. Is it that babies hear their own laughter or the laughter of others for laughter to mature? If so, is there any critical period during which laughter must be experienced? The report of laughter in a few congenitally deaf-blind children suggests that at least some features of laughter develop without benefit of auditory and visual stimulation, evidence of a strong maturational and genetic basis. However, for a more satisfying account of laugh acquisition, high resolution studies are required to be conducted to understand the contrast of development of laughter in normal and hearing-impaired children [2].

We often laugh because someone else is laughing. According to researches [4], comedians laugh 46 % more than listeners. It is based on their subconscious thinking that if they laugh, the audience is likely to laugh. This subsequently makes the speaker more comfortable while performing. When we laugh, two important proteins, namely endorphins and interferongamma (IFN) are released. These are endogenous peptides. Endorphins act as natural pain killers and arouse a sense of happiness and calmness in our body. These also protect us from stress, hypertension and depression, increase our memory and keep us healthy and cheerful. IFN activates T cells, B cells, immunoglobulin and NK cells in our body which in turn helps to fight viruses, strengthens our immune system and regulates cell growth [3].

About 2000 years ago, Physician Galen stated that cheerful ladies have lesser probability of getting cancer than depressed ladies. According to a 1989 study [3], laughter can decrease the serum levels of cortisol, dopac, epinephrine and growth hormones. When we laugh, we make gestures and sounds due to which our facial muscles contract. A 2010 study [5] reported that our body responds to repetitive laughter and repetitive exercise in a similar manner. Positive emotional activities have been suggested as modifiers of neuroendocrine hormones involved in the classical stress response. These hormones result in certain biochemical changes which have implications for the reversal of the neuroendocrine and classical stress hormone response.

Scientists do know that laughter is a highly sophisticated social signaling system, helping people bond and even negotiate. Interestingly, most social laughter does not result from any obvious joke. Although laughter is not generally under voluntary control, it has numerous health benefits. It releases tension, lowers anxiety, boosts the immune system, and aids circulation. Laughter Yoga is claimed to promote mental health and is increasingly becoming popular worldwide. Despite its popularity, there has been no systematic review of Laughter Yoga intervention studies and thus evidence of its effects on mental health is unclear [6].

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Kolkata, a city that never loses charm

BHASWATI MEDHI,
PH.D SCHOLAR

I visit Kolkata at least once a year, be it for some work or visiting relatives, or any other reason. But Kolkata happens to me for minimum once per year. And as usual, the ‘City of Joy’ never failed me.

This time I visited a relative’s place in Kolkata and I thought of jotting down my feelings for the place. As one lies on bed, he or she could hear somebody shrieked with laughter, passing by. Through the floral designed whitish curtains, light glows. A lorry thundered past, or a train in the nearby railway track, rattling the windowpanes. Whether early in the morning or at the midnight hours the place is seethed with life, sometimes it seems to be very noisy.

Amidst the noises, and the nest of greens, a bird cries, it's like an alarm call, a screeching sound like a carving knife being sharpened. Something barks at the midnight hours, far away. The moon paints my place in silver, making things look just a little more alive. Moonlit coconut leaves will cast a spell on you without a doubt.

Walking down the lanes, one finds by-lanes connecting one lane to the other. There are five lakes in the area from which has been derived the name of the place -Panchasayar. On either side of the lanes and by-lanes there are planned houses, mostly two storied and around them a distinct stretch of life.

Walking into the roads, footpaths, I heard cries of

“Oh Boudi, eitadekhun! Darunlagbe,” from shopkeepers, flattering and persuading customers simultaneously into buying the latest collections.

The tangy smells of puchkas hit me as soon as I exited out of a shopping complex, tempting me to just give it a try.

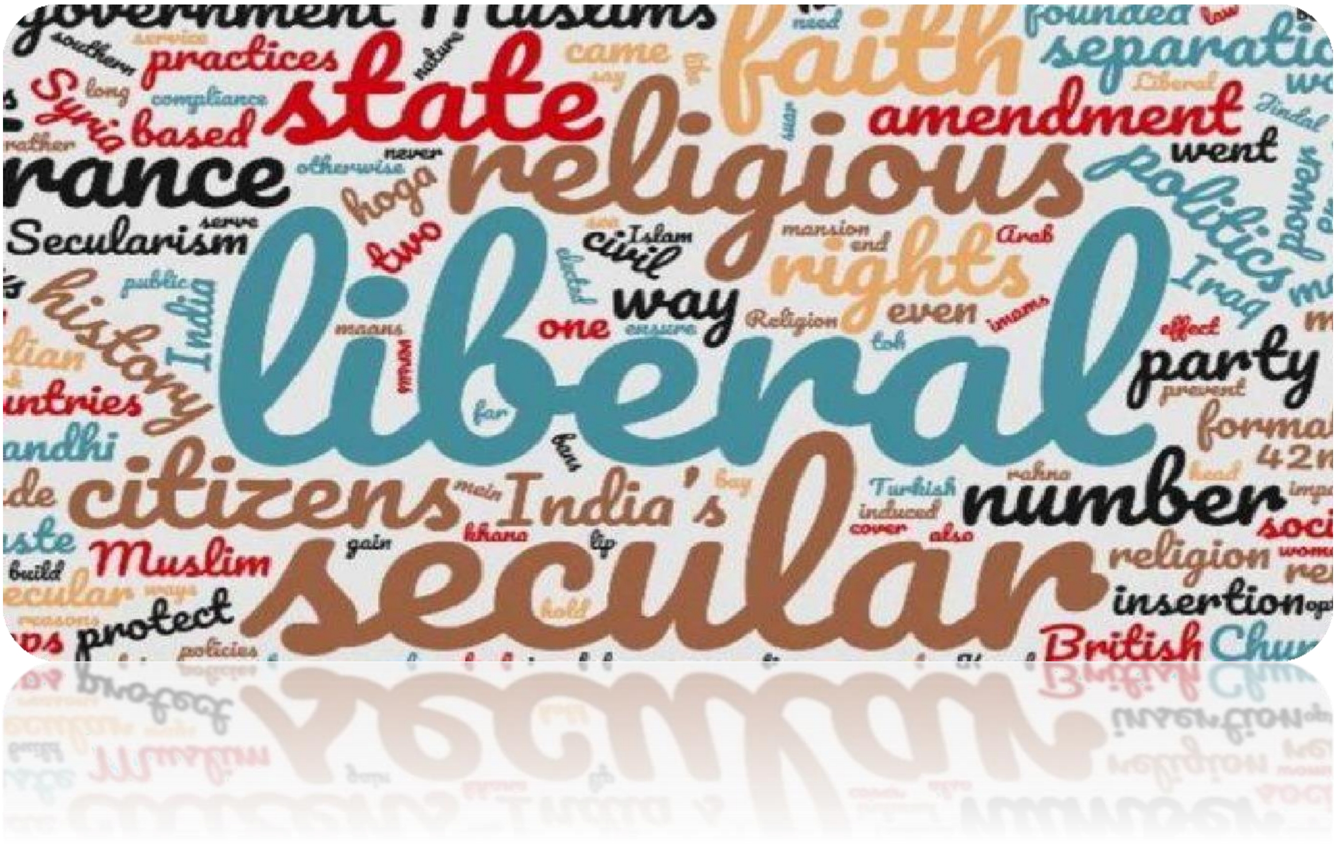
Puchka, otherwise known as ‘panipuri’ all over India, is the ultimate snack to gobble up during an evening stroll through the streets of Kolkata.

With all the commonplace tidbits, the residents of Kolkata will all widely agree that their city is aptly named the ‘City of Joy.’ Whether you casually walk down the busy streets of Kolkata or hop into the yellow taxi to travel around the city, there is an undeniable charm that the city emits – with its old buildings, the tram lines that run through the city, architecture from the British era and the local people sitting outside tea shops, having their daily conversations called ‘adda’ for which Bengalis are famous for.

Last, but not the least of course Kolkata is perhaps the most soulful city in India. Contrary to the picture painted in Dominique LA Pierre’s novel City of Joy, Kolkata is vibrant, uplifting and probably the friendliest city in the lot. Strangers will invite you for a chai just to talk and exchange ideas. Friendships are struck up in an instant and the city is abuzz with intellect and creativity.

COMMUNALISM AND THE COUNTRY

SUBHRANIL DATTA, 1ST YEAR



"I shall work for an India in which the poorest shall feel that it is their country, in whose making they have an effective voice, an India in which there shall be no high class and low class of people, an India in which all communities shall live in perfect harmony." – Mahatma Gandhi, India of my Dreams.

Seventy long years have gone by since Mahatma Gandhi, the father of our nation and the Pioneer of the Indian freedom struggle, was assassinated when he was 79 years old. Mahatma Gandhi devoted his entire life for encouraging communal solidarity. Gandhiji spent the final days of his life in Delhi challenging the turmoil that was born out of the agony of Partition.

Hindus constitute the majority of 132.42 crores people living in India; people belonging to other religions such as Islam, Christianity, Sikhism, Jainism, Buddhism also co-exist in this nation. Aside from the eight major religions, there are 3,000 odd castes, 25,000 subcastes, 780 different languages, seven union territories, and a sizeable population of people belonging to different tribes and sects.

The 42nd Amendment to Constitution of India, which was enacted in 1976, amended the preamble to the constitution and changed the description of the nation from a "sovereign democratic republic" to a "sovereign, socialist secular democratic republic". The Preamble asserted that India is a secular country, i.e. there should be equality of all religions in India, along with religious tolerance and respect. Even the Upanishads, the ancient Sanskrit Scriptures, preach "Sarva Dharma Sambhava" which translates to "Respect for all belief systems".

Prabha Dixit, a renowned author, defined communalism as a political doctrine which makes use pf religious and cultural differences to achieve political ends. Communalism is characterized by rivalry, violence and tension amongst masses, and it is in stark contrast to the ideals of democracy, secularism, and national integration.

There was a point of time, perhaps, when we might have taken the idea of a secular, pluralistic India, tolerant of all sects and religions, as a position set in stone. But, incidents, especially since the early 1990s, have radically altered both reality and our imagination.The last decades have bore testimony to a rapid spike in communal violence in India. Firspost, a leading news and media website, reported that India witnessed 822 communal incidents in 2017 which resulted in more than 100 casualties, and atleast 2,000 people were injured in the violence.

Hansraj Gangaram Ahir, the MoS Home Affairs, stated in the Lok Sabha that the highest number of incidents were reported in Uttar Pradesh where 44 people were killed and 542 others were injured in 195 communal incidents. According to reports, Karnataka has seen almost a hundred incidents of violence last year in which there were 9 casualties and 229 people were injured. Around 12 people reportedly died as a result of communal discord in Rajasthan.

Jawaharlal Nehru, the first Prime Minister of India, believed that a functional government structure must encourage and sustain religious diversity. While Gandhi believed strongly in spiritualisation of political life, Nehru advocated the separation of politics from religion. However, both Gandhi and Nehru were united by their desire for a secular India. It was the horror of Partition that sealed Nehru's and Gandhi's drive for a secular democracy following independence. But half a century later, the legacy of Anti-communal struggle that was spearheaded by political leaders like Gandhiji, Nehru, Bal Gangadhar Tilak, has surrendered to the widespread communal dissonance across the country.

The few surviving freedom fighters lament how India has moved on from the ideals of equality, justice, and Dignity for all. The vast saga of great sacrifices, inspiring courage, and the overwhelming commitment to securing liberty from the bondage of colonial rule, has now been replaced by nationalism.

The cycle of communal hatred and violence can be stopped only by ending first the false equivalence between minority and majority communalism. Efforts should be made through mass media for changing the attitude of people towards other communities. People must be aware of the evils of the communalism. Communal disharmony not only threatens democracy and national integrity but is also a huge threat to our progress as a nation. We have to try to create a faith in all minor religious communities, that their feelings, faiths, ways, and places of worship would not be tolerated anyway. Respect of their thoughts and customs would arouse it into them. Political parties should keep themselves away from the communal issues, or the issues that enthreat the communalism. This is the only easy way, we can keep our unity and integrity safe and secure.

"All truly great thoughts are conceived while walking."
— Friedrich Nietzsche

The walk

MISHU RAJA,
2ND YEAR

How many of you go out for a morning walk? It is very refreshing and calms our agitated nerves and meanwhile gives a sense of happiness too. It's quite an easy thing to understand when it comes to walking. Here, it isn't about the morning walk which one starts and ends at the place he began. It's about the walk through life, where mirth can turn into misery in no time, and where even a beggar may end up as a king. The walk through life is walked mostly alone albeit the fruitful assistance from love ones.

How does it start? Crucial junctures in life demand tough decisions to be made and the complexity increases if it is related to making the current state better than the past. It is then we make the choice of opting for a path which would suit us better in future and we make efforts to make it happen in real. The moment we start moving on our pre-decided path, we must commit ourselves to it dully.

Primarily, there must not be any hesitation or doubt inside us, at the first place, about our choices. Nothing great can be achieved easily. Hurdles, difficulties are bound to strike your way but that should not make you retreat. Having strong will power is extremely necessary to achieve one's dream. Expectation is one of those things which cause immense disappointment and disbelief. In your quest to glory, you cannot keep expecting of yourself. It hampers your efforts by a big margin.

Once you have set your foot on the chosen path, you must not regret. Regret is the trickiest challenge which everyone has to face at one stage of their life. Those who are able to pass through it unscathed evolve to be more successful and full of mirth as compared to their counterparts who fail to do so. It happens that we are guilty of the choices we made earlier. After all, mistakes are committed by mortals. This fact has to be realized gleefully, and, instead of letting oneself down, one should hold their head high and learn from their flaws. Perfection can be accomplished by minimizing errors which is possible only when there is a space for learning.The most difficult thing to overcome while walking through life is fear. Fear of death, misery, pain and the most dangerous of all, fear of failures. It is obvious that every one of us is afraid of failing in life. Fear cannot be and should not be removed completely. Removing fear is not the appropriate solution. The apt way of dealing with fear is bravery and it involves overcoming the fear. Being fearful, one becomes too indecisive to take bold decisions in his/her way. Fighting your fear with courage is the signature of your will to do something you want. Ignoring the drawbacks of any decision made is foolish because one has to maintain the balance between positive and negative. At the same time, thoughts of failing should not overpower the thoughts of succeeding. One has to be positive and yet mindful to be able to move forward smoothly.

Life is known for its twists and turns but amidst these disturbances lays the secret of being able to chase one's dreams. Yes, it will happen that we will get hurt someday in form of failures, turbulences, breakups, etc. But we have to get over it and start moving again because life neither started nor will end at a point. Remember those days when our parents taught us to walk? They first helped us but then slowly as the time progressed we were left on our own to walk through our life. It is true that we fell initially when they left us for the first time but then we stood up and started walking again. This process continued until we didn't fall again. What we can learn from that little part of our life is that no matter how many times we fell, we stood up, walked and moved our way forward. Life is full of stoppages, all of which have something good in store for us. It's up to us to terminate the evil and extract the heaven out of the results obtained from the sincere efforts made by us. The walk through life is indeed a tough one but certainly not one that cannot be completed as desired by us. It doesn't ends with criticism or failures, it ends only when one quits. Never quit midway on your chosen road because then you will be left with no explanations to even console yourself. Moments of despair are definitely going to be a huge part in this journey but it will only help to stabilize and become stronger than before. *'Learn a way to enjoy the agony, it helps, because then even walking with twisted ankles would feel like performing a moonwalk.'*

"True, you may see the end of road today from distance and stop way ahead thinking it's all over, that doesn't mean the road ends. The point where you think the road ends is actually the point where new roads originate and that is why you should never stop prodding forward in this clumsy life which can be sweet or bitter at any instant……"

Keep fighting. Keep chasing. Keep walking THE WALK

HINDI SECTION

MERI MAA

SUBHRADEEP BANIK,

2ND YEAR

Pehli bar jab ankhe kholi, to tumhe hi samne paya,
Pehli bar jab mene bola, to labso me tumhara nam hi pehle aya.
Chot mujhe lagti, par dard tumhe hota,
Exam mera hota, par tension tumhe jyada hota.
Jeet ta me tha, khusi tumhe jyada hoti,
Har ta me tha, par us har ko jitney ka hosla tum hoti.
Mere life ki har problem ka solution ho tum,
Tum or koyi nehi, meri maa ho tum.

FARE WELL

SUBHRADEEP BANIK,

2ND YEAR

Raste ye kab khatam ho gaye

Pata hi nehi chala,

Manzil pe kab pohoch gaye

Waqt ka bhi kheyal na raha,

Sang tumhare safar ye kab bit gaya

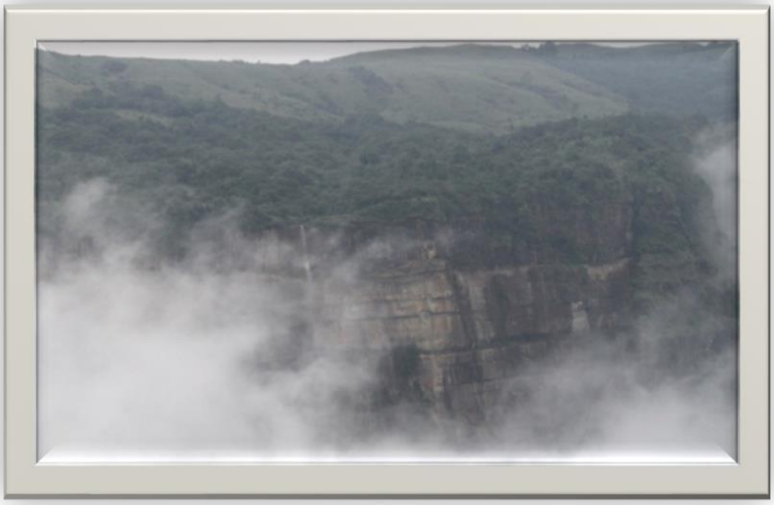
Suhane palo ka ek guldasta ban gaya,

Yeah pal hamesa yaad ayenge,

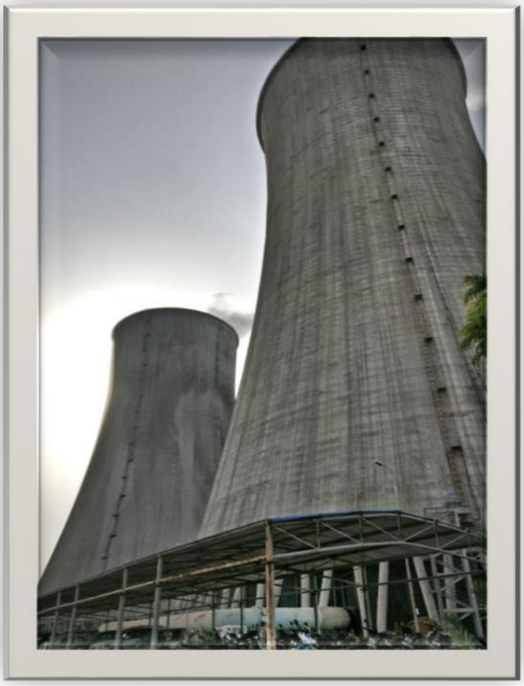
Tum hamesa hamare dil me

Aise hi zinda hoke reh jayoge…


PHOTOGRAPHY



ANKUR BISWAS, 3RD YEAR



E. THARUN, 2ND YEAR

NABANITA DAS, 3RD YEAR

PAINTINGS

ANWESHA SAHA, 1ST YEAR

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