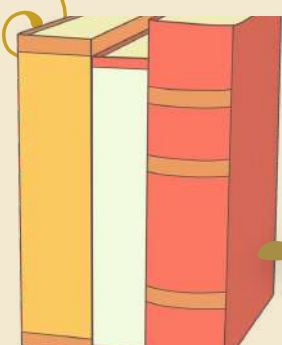




SPARK



Department of Electrical Engineering



HOD'S DESK

I am thrilled to announce the publication of our departmental magazine, "Spark". I want to express my deep appreciation to both our dedicated students and faculty members who worked diligently within a tight time frame to make this publication possible. I extend my heartfelt gratitude to Prof.(Dr.) Nabamita Banerjee Roy for her visionary leadership in spearheading the creation of "Spark".

Her dedication and exceptional leadership have been instrumental in bringing this project to fruition.

"Spark" promises to be an invaluable platform for all the students in the EE department, offering opportunities to refine their skills in innovation, research, literacy, and poetry. Our esteemed staff will play a pivotal role in enhancing the magazine's content by featuring articles on emerging technologies and lateral developments.

I am confident that "Spark" will exceed expectations and become a source of delight, inspiration, and intellectual enrichment for everyone in our department.



**PROF. DR. SAIBAL
DUTTA**

MESSAGE

FROM Faculty Coordinator

It is my immense pleasure to bring forward the 2nd Edition of the Magazine of Electrical Engineering Department “**Spark**”. This Edition has taken another leap forward incorporating a large number of rich contributions of our students, faculty and alumni. The topics of the contributions belong to both technical and non-technical domain.

The technical contributions are not only enriching, but they will provide the readers an insightful knowledge of the latest technological developments and research that are in the process. The non-technical contents are multi-dimensional. They include magnificent work of art and literature, showcasing the talent of every contributor.

The alumni section is another added flavor of this Edition. It will not only provide the readers a sense of nostalgia but will give them an inexplicable feeling of joy during the journey of reading.

I do not have proper words to express my gratitude to our students whose hard work has been reflected in every page of this Edition. I am equally thankful to our faculty and off-course our alumni for their enriching contribution and for being a part of this Edition, which will motivate the future generations.

I express my best wishes to all and look forward to the third Edition of “Spark” which will take us another step ahead uplifting the glory of Electrical Engineering Department, Heritage Institute of Technology.



Dr. Nabamita Banerjee Roy,
Associate Professor, Dept EE
Heritage Institute of Technology
Member of IIC, HITK
Life Member: AMIEE Association and IE(I)



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MESSAGE

FROM

Alumni & Seniors

Spark isn't just a magazine; it's a testament to the bright ideas and relentless energy our department generates. May it continue to ignite curiosity and passion in every reader -**Arya Ghosh**

In a world full of noise, - 'Spark' is a clear signal of our department's achievements and creativity. It's a publication with high frequency and zero interference.- **Kiran Kumar**

Spark' is more than a collection of articles; it is a repository of our collective intellect and curiosity. May it serve as a beacon of knowledge for all students navigating the complexities of this field. - **Subhradeep Mandal**

Being your passout senior, I wanted to share a few words with you. The years ahead will be filled with incredible highs, but also a few academic hurdles. Please, don't let them define you. I've been there. The secret isn't to be perfect, but to be persistent. Don't be afraid to ask for help—from professors during office hours, from a friend Or senior for a study session, or from the resources on campus. -**Ranadhir Roy**

THE 2nd EDITION | 2025

MESSAGE

FROM Alumni & Seniors

Congratulations on creating 'Spark'! May its pages be brighter than our career paths and its content more stable than my final year project. - **Debopriya Ghosh**

'Spark' is more than paper and ink; it's the heartbeat of our department's community. The team's incredible effort has given all of us a platform to share our stories and feel more connected than ever." - **Amlan Banerjee**

Let's take a moment to acknowledge the immense effort that has gone on behind the scenes. The 'Spark' team has given our department a wonderful gift: a stronger sense of identity and togetherness. - **Soumyajit Banik**

THE 2nd EDITION | 2025

MESSAGE

FROM THE TEAM

"Behind every page of 'Spark' are countless hours of collaborative effort. This magazine is a beautiful testament to what our students can achieve when they unite with passion and a shared vision for the department.- **Samadrita Ghosal**

To see 'Spark' transition from a mere concept into this polished, tangible publication is a monumental achievement. It's proof that our department not only engineers circuits but also creates powerful platforms for our collective voice. - **Aditya Shome**

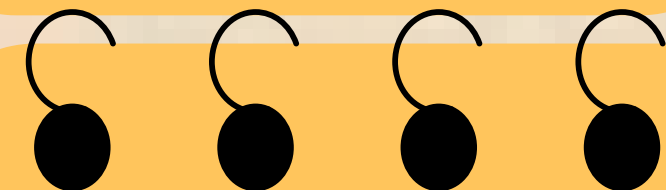
'Spark' is more than paper and ink; it's the heartbeat of our department's community. The team's incredible effort has given all of us a platform to share our stories and feel more connected than ever. - **Sayandip Mondal**

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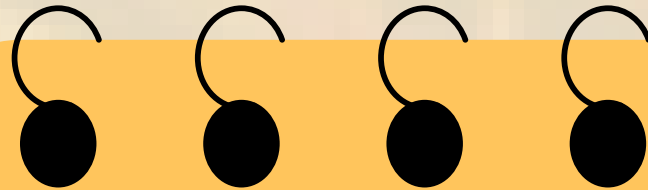
MESSAGE

FROM THE TEAM

We often focus on our individual projects, but 'Spark' reminds us of the power of collaboration. The dedication poured into this by the team showcases the heart and soul of our department, not just our technical minds.- **Arya Talukdar**

Talukdar

The legacy of 'Spark' will be twofold: the excellent publication itself, and the inspiring example of teamwork set by its creators. They didn't just make a magazine; they strengthened the fabric of our departmental family-

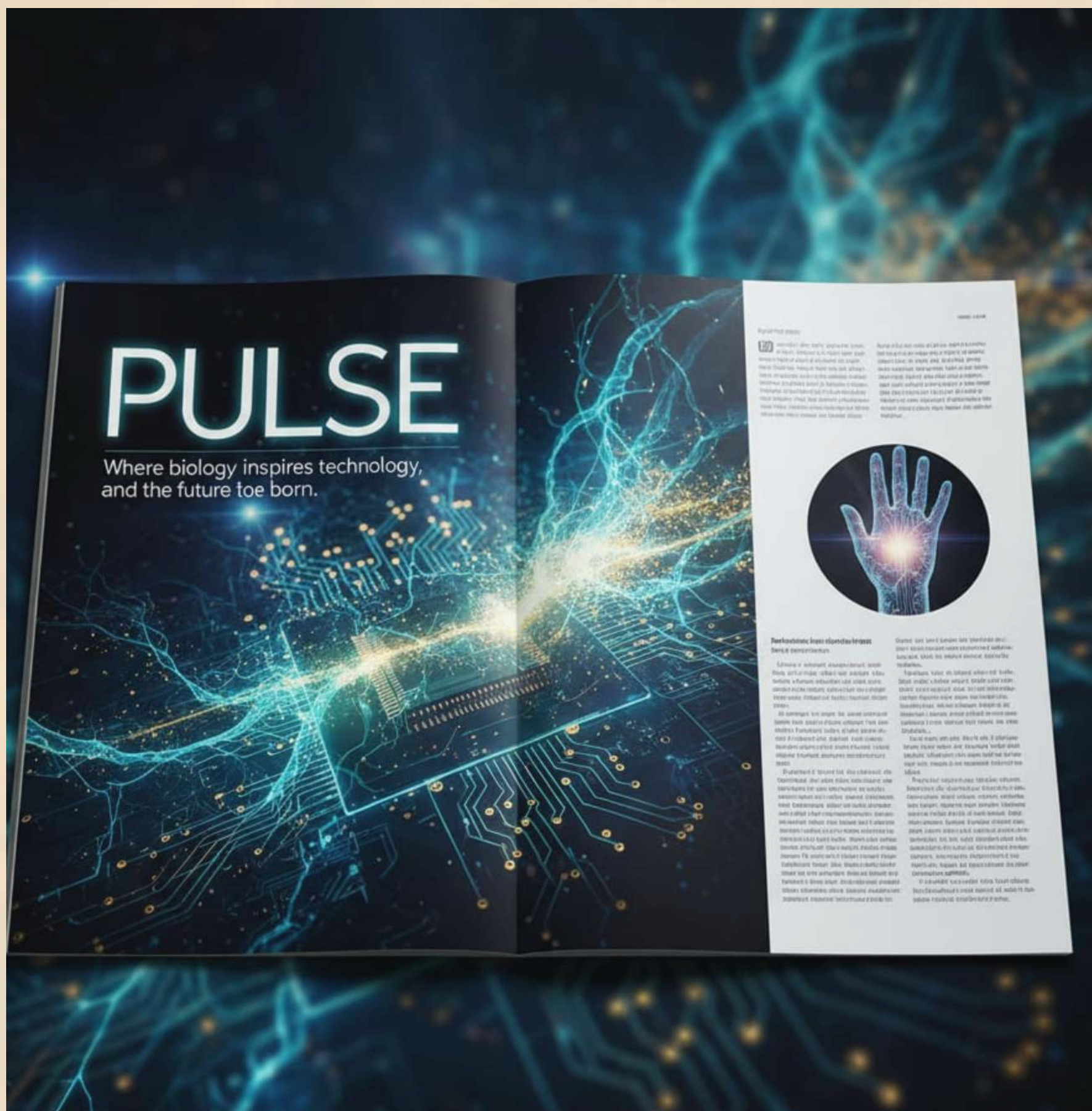
Aneesh Paul

Let's take a moment to acknowledge the immense effort that has gone on behind the scenes. The 'Spark' team has given our department a wonderful gift: a stronger sense of identity and togetherness.- **Archit Mondal**



Our department has many brilliant minds working in different domains. The success of 'Spark' lies in its ability to weave these separate threads into a single, shared narrative, thanks to the unifying effort of its creators.- **Aritra Banerjee**

Banerjee



Artificial Synapses: Bridging Biology and Electronics

-Prof. Reetwik Bhadra

The human brain is one of nature's most remarkable computing machines. It processes vast amounts of information with extraordinary efficiency, all while consuming only about 20 watts of power—less than a standard light bulb. At the heart of this ability lies the synapse, the tiny junction between two neurons where electrical signals are translated into chemical activity and back again. Synapses allow the brain to learn, adapt, and store memories. Inspired by this mechanism, scientists and engineers are now building artificial synapses, electronic devices designed to mimic the brain's way of processing information.

What is an Artificial Synapse?

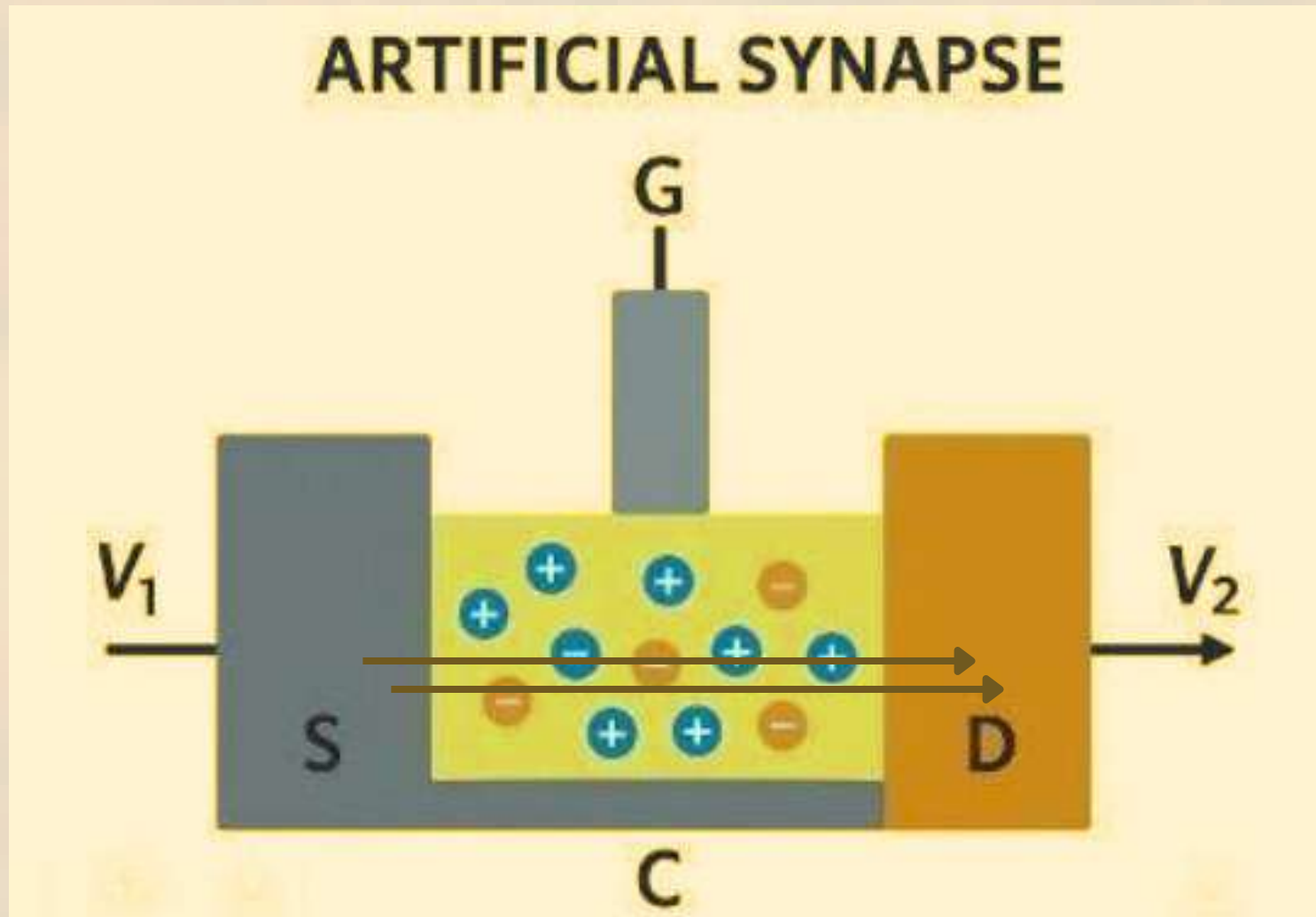
An artificial synapse is a nanoscale electronic device that emulates the behaviour of a biological synapse. Instead of neurotransmitters, these devices use ions, charges, or resistive states to transmit and store signals. Their primary function is to regulate the strength of the connection—known as synaptic weight—between artificial neurons in neuromorphic hardware systems. Just like in the brain, this adjustable strength allows



Why was the *power cord* lonely?
Because it was
always a-part of the
outlet.

machines to “learn” from repeated inputs. Unlike traditional transistors used in computing today, artificial synapses are not limited to binary states (0 and 1).

Instead, they can hold a continuum of states, much like the varying strengths of biological synapses. This feature makes them an ideal candidate for building brain-like computing systems.



Why Do We Need Artificial Synapses?

Today's computers follow the von Neumann architecture, where memory and processing units are physically separated. This creates a bottleneck—data must constantly move back and forth, wasting both time and energy.

Artificial synapses, on the

other hand, integrate memory and processing in the same location, much like the brain. This in-memory computing approach drastically reduces energy consumption and improves speed.



Why did the
electron look sad?
Because it was
going through a
period of low
charge.

For tasks such as image recognition, speech processing, and adaptive control systems, artificial synapses could offer orders of magnitude improvements in efficiency compared to conventional silicon chips. Imagine smartphones that can learn your habits locally without needing cloud servers, or medical devices that process neural signals in real time with minimal power.

Materials and Technologies:

Researchers have explored several material platforms for artificial synapses, including:

Memristors – devices whose resistance changes depending on the history of voltage applied. They are one of the most popular candidates because of their simplicity and scalability.

Electrolyte-gated transistors (EGTs) – these use ion movement in electrolytes to mimic neurotransmitter activity. They are especially promising because of their close resemblance to biological processes.

Phase-change materials – substances that can switch between amorphous and crystalline states, storing information in the process.

Each of these technologies has its strengths. Some offer fast

switching speeds, others provide better endurance, while a few can be manufactured at large scale. The field is still in rapid development, with new materials and architectures emerging every year.



Why do they call it *direct current*?
Because it's *straight* to the point!

Learning and Memory Functions:

Artificial synapses are not just static memory devices—they can learn. By applying sequences of voltage pulses, researchers can strengthen or weaken the device's conductance, mimicking the processes of potentiation (learning) and depression (forgetting). This is how machine learning algorithms can be directly implemented in hardware.

Some devices even demonstrate short-term and long-term memory behaviours, just like the brain. Short-term memory fades quickly, while repeated signals consolidate it into long-term memory. Such functions are vital for enabling adaptive, intelligent machines.

Future Outlook:

Artificial synapses are paving the way for a new computing era known as neuromorphic engineering, where machines think and learn more like humans. While challenges remain—such as improving device reliability, scaling up production, and integrating billions of artificial synapses into functional systems—the progress so far is encouraging.



Why did the *voltmeter*
break up with the
ammeter?
They just couldn't
agree on the flow.

The ultimate goal is to build hardware that approaches the brain's unmatched balance of efficiency, adaptability, and intelligence. If successful, artificial synapses could power the next generation of smart electronics,

from self-driving cars and robotics to personalized healthcare systems.

Conclusion:

Artificial synapses represent a bold step toward bridging biology and technology. By imitating the way our brains learn and adapt, these tiny devices could revolutionize the future of computing. What once belonged to science fiction is rapidly becoming reality: machines that don't just calculate but truly learn.



An electron walks into a bar.
The bartender says, "Why so negative?"
The electron replies, "Because I lost my charge!"
A proton at the next table laughs and says, "Don't worry, stay positive!"
Meanwhile, a resistor at the corner mutters, "Ugh... I hate all this current drama."
The capacitor just sits quietly—still waiting for the right moment to store up energy.

Semiconductor-Based Biosensors: A New Frontier in Healthcare

-Prof. Anirban Kolay

The rapid advancement of semiconductor technology, which has already transformed computing and communication, is now making a strong impact in the field of healthcare through biosensors. A biosensor is a device that combines a biological recognition element—such as enzymes, antibodies, or DNA—with a transducer that converts biological interactions into measurable signals. When semiconductor materials are integrated into these devices, they bring high sensitivity, miniaturization, and compatibility with modern electronics, making them ideal for next-generation medical diagnostics.

At the heart of semiconductor-based biosensors lies the Field Effect Transistor (FET) principle. In such devices, the binding of a biomolecule (for example, glucose, cancer markers, or viral proteins) at the sensor's surface alters the electrical properties of the semiconductor channel. This change in current or voltage can be precisely measured, providing a

rapid, label-free, and real-time detection method.

Compared to traditional laboratory tests, semiconductor biosensors are portable, require only a small sample volume, and can deliver results within

What's an

electromagnet's
favorite band?

*AC/DC—they're
really **attractive*

minutes. One of the most promising applications is in cancer diagnostics. Early detection of cancer biomarkers such as specific proteins, DNA mutations, or microRNAs is vital for successful treatment. Semiconductor biosensors are capable of identifying these biomarkers at extremely low concentrations, even in a single drop of blood. This opens the door to minimally invasive, point-of-care cancer testing, enabling timely diagnosis and monitoring without the need for lengthy laboratory procedures.

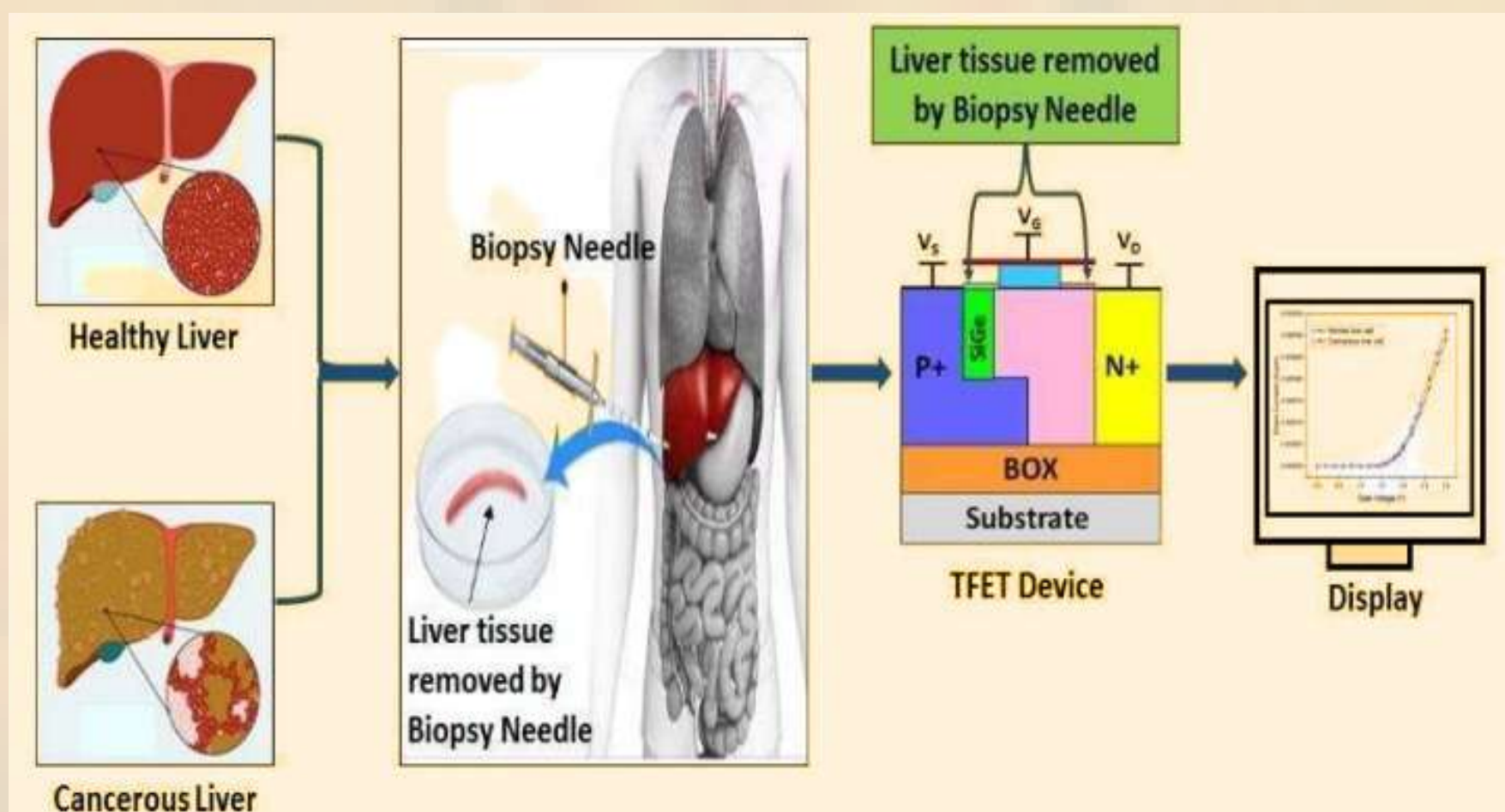


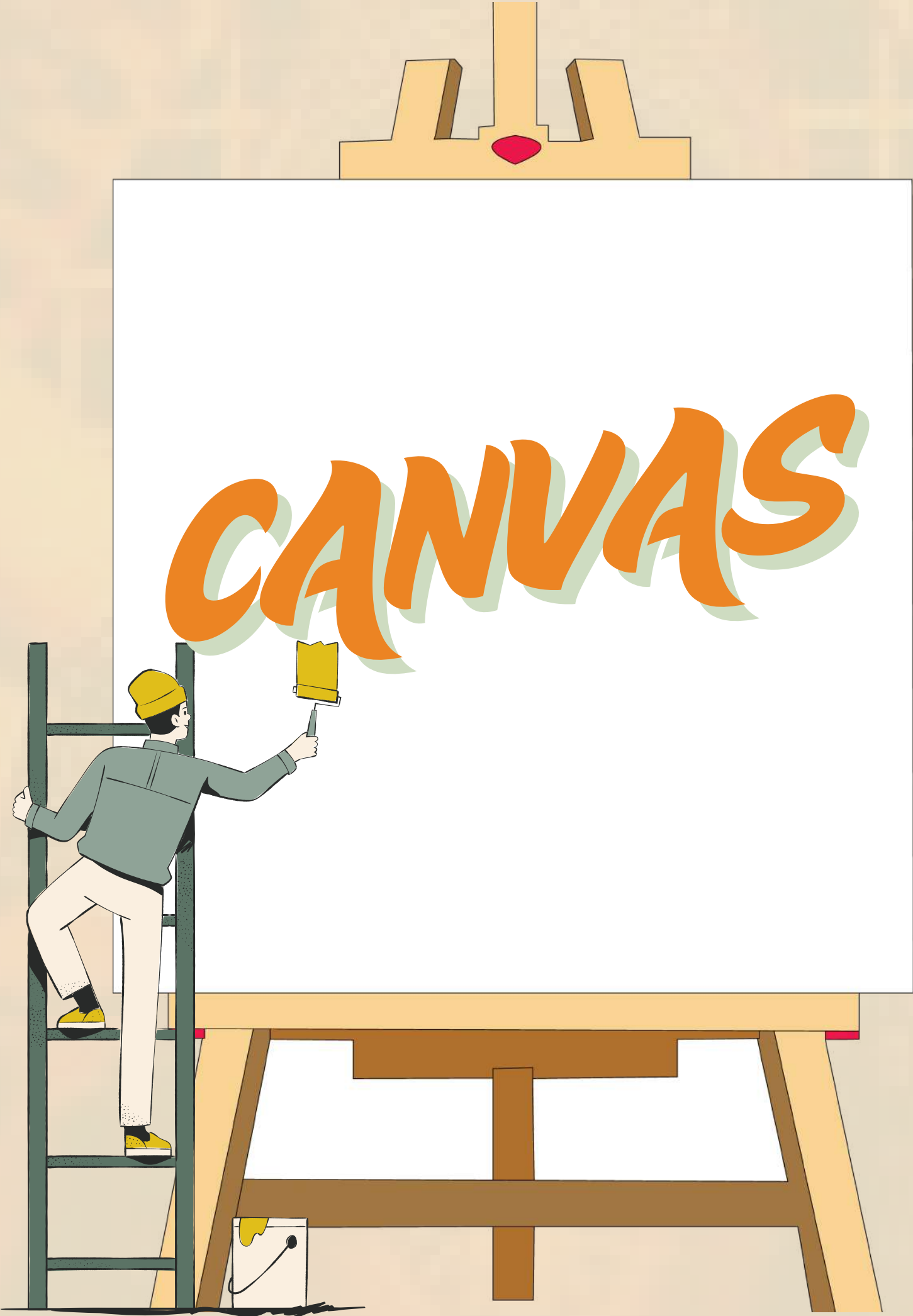
Fig. 1. Detailed representation of stages involved in Liver cancer cell lines detection, healthy or cancerous liver cell line obtained by needle biopsy samples which can be detected by Tunnel FET (TFET) device because of the variations in the electrical properties of the cell lines

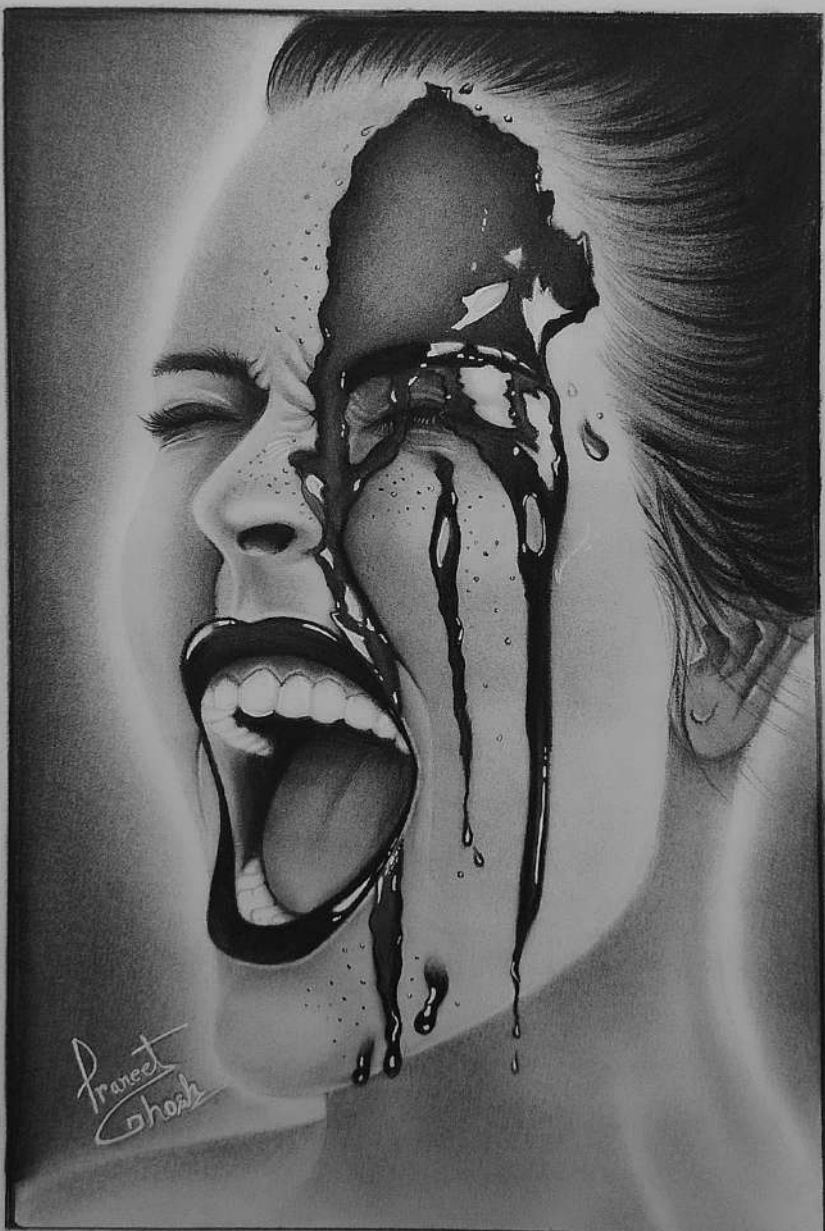
The applications of these devices go beyond cancer detection. In diabetes management, semiconductor glucose sensors already help millions of patients monitor blood sugar levels with greater ease. Researchers are also developing biosensors for neurological disease diagnostics, infectious disease detection, food safety monitoring, and wearable health trackers.

What makes semiconductor biosensors especially promising is their scalability and affordability. Since they can be fabricated using the same techniques as computer chips, mass production is possible at low cost, making advanced healthcare accessible even in resource limited settings.

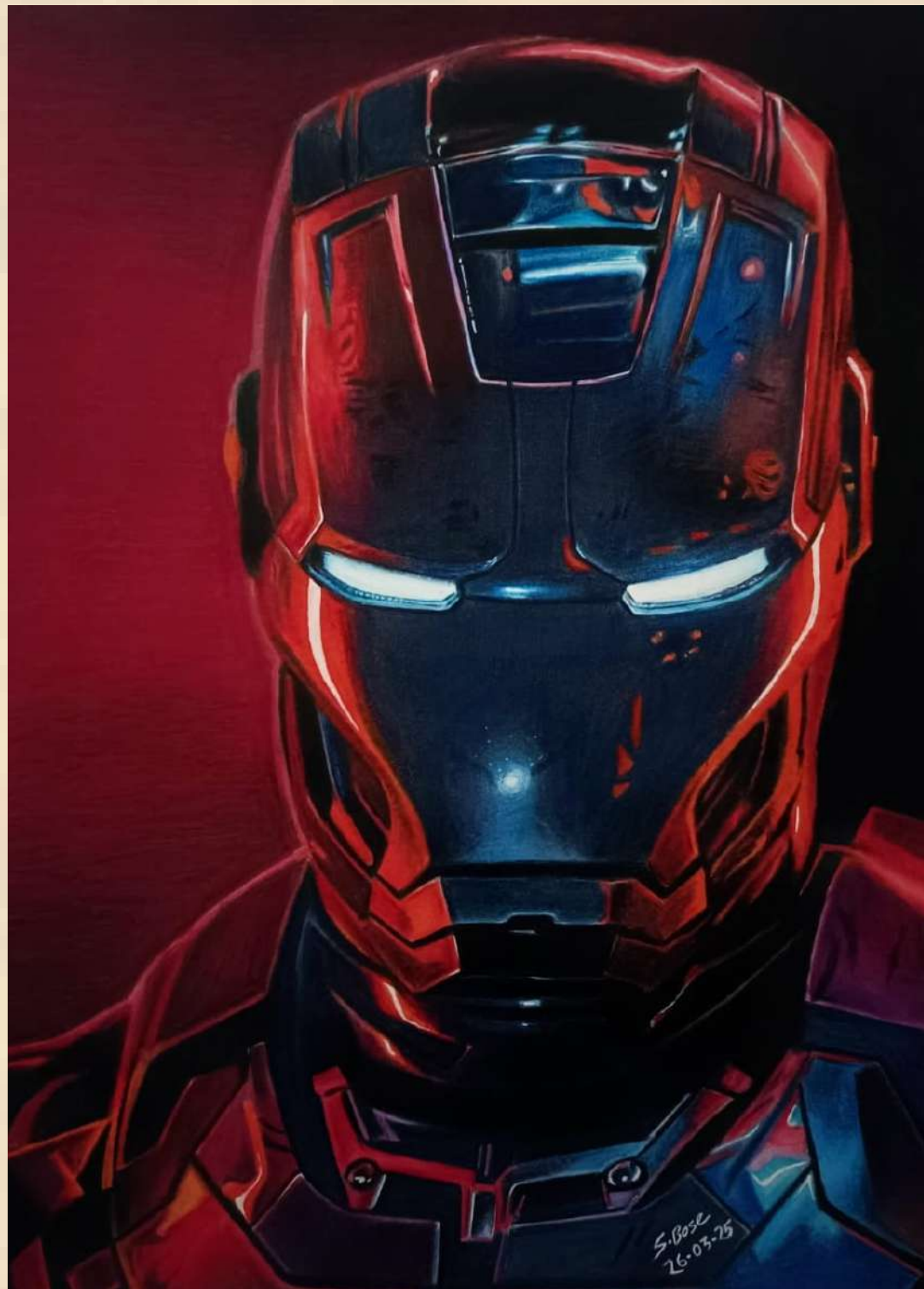
As research progresses, the integration of biosensors with smartphones and artificial intelligence is expected to create powerful point-of-care diagnostic tools. These devices may soon allow individuals to carry their own "personal lab," enabling real-time health tracking, early cancer screening, and personalized medicine.

In essence, semiconductor-based biosensors represent the convergence of biology and electronics, shaping a future where medical testing is faster, more reliable, and within everyone's reach.



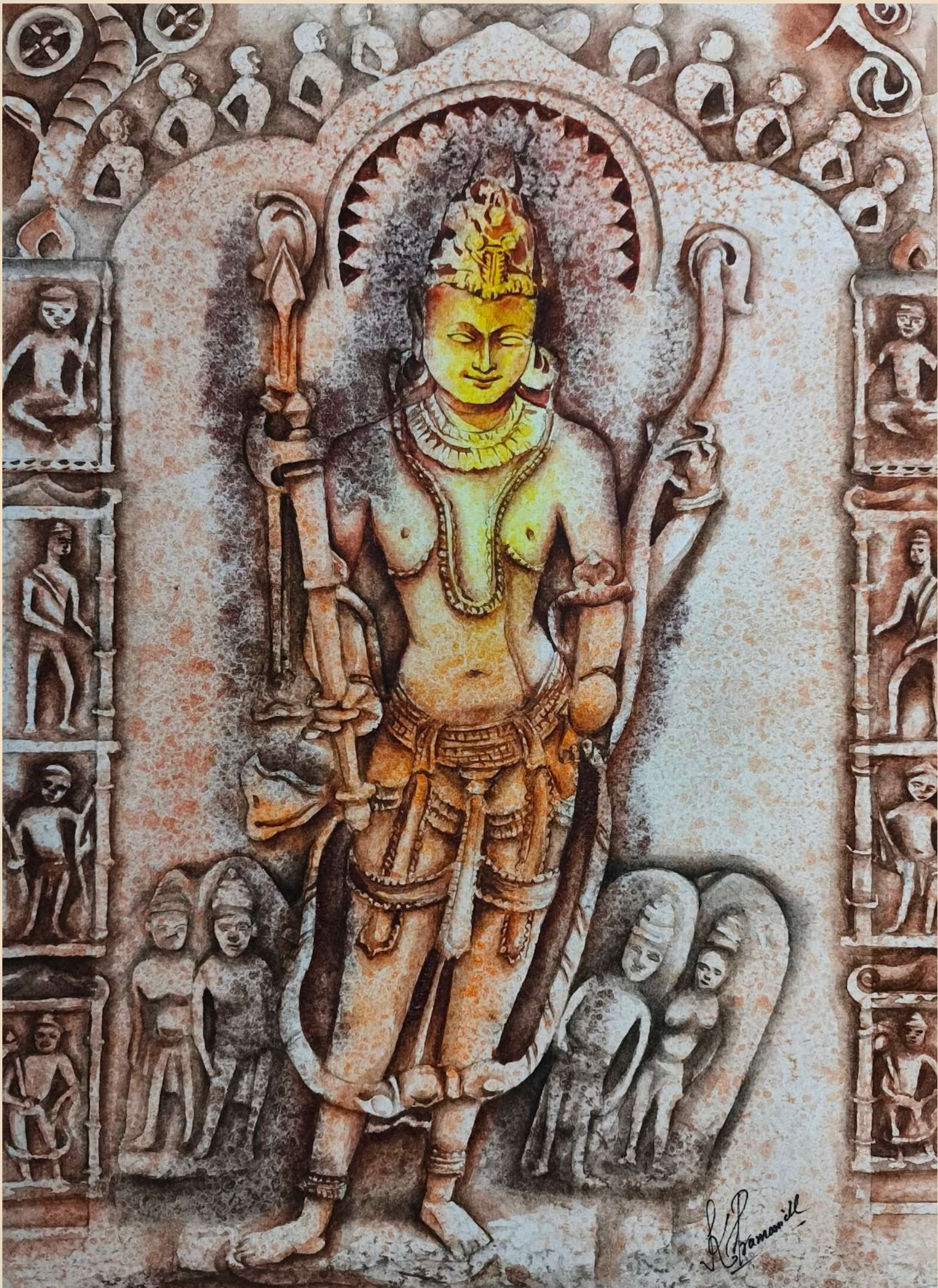


- Praneet Ghosh



- Subhradeep Bose

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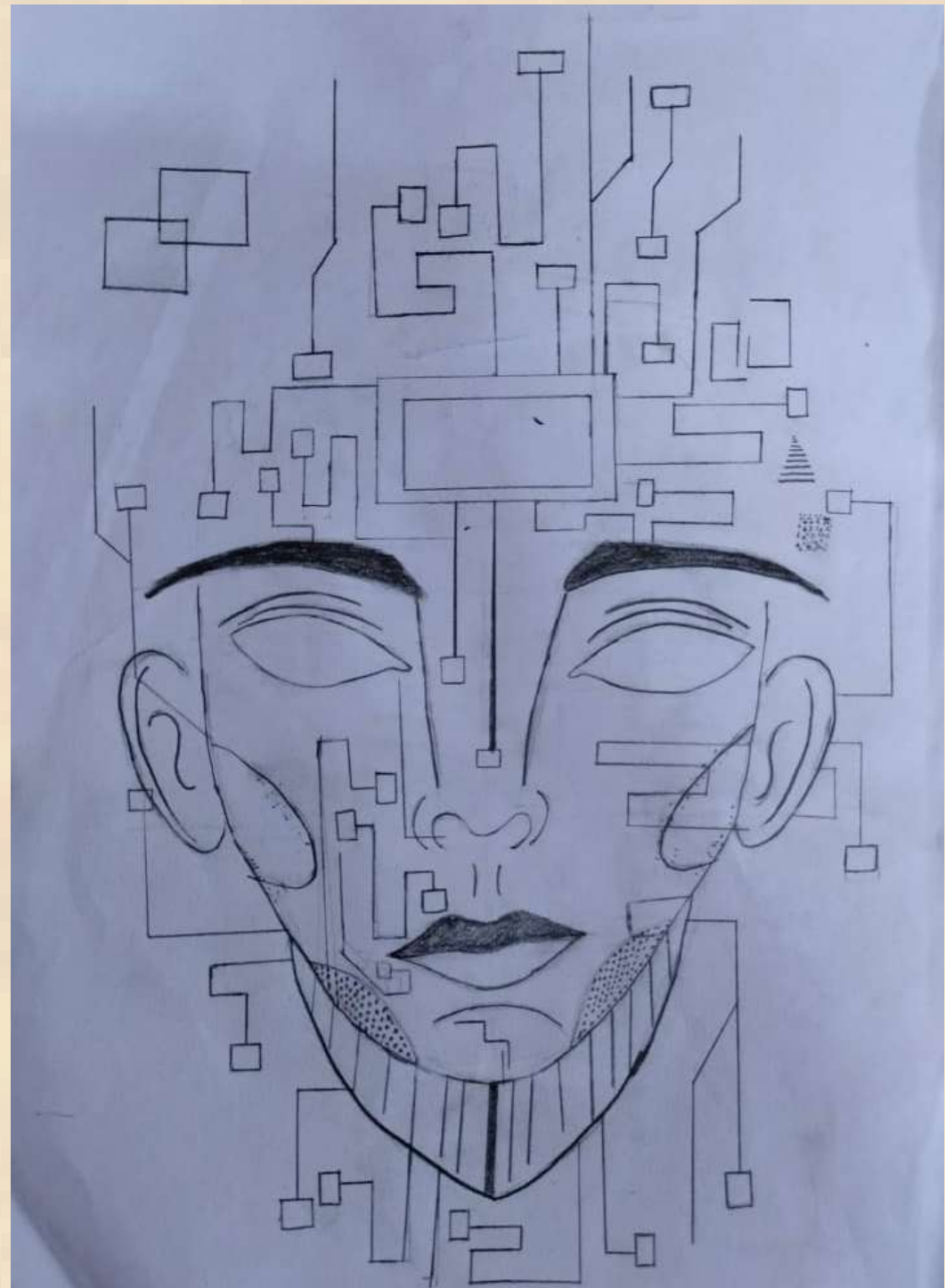
- Katharoop Pramanick, 3rd Year



- Soumyasree Chatterjee, 3rd Year



**- Debopriya Ghosh,
4th Year**



**- Dipannita Das,
2nd Year**



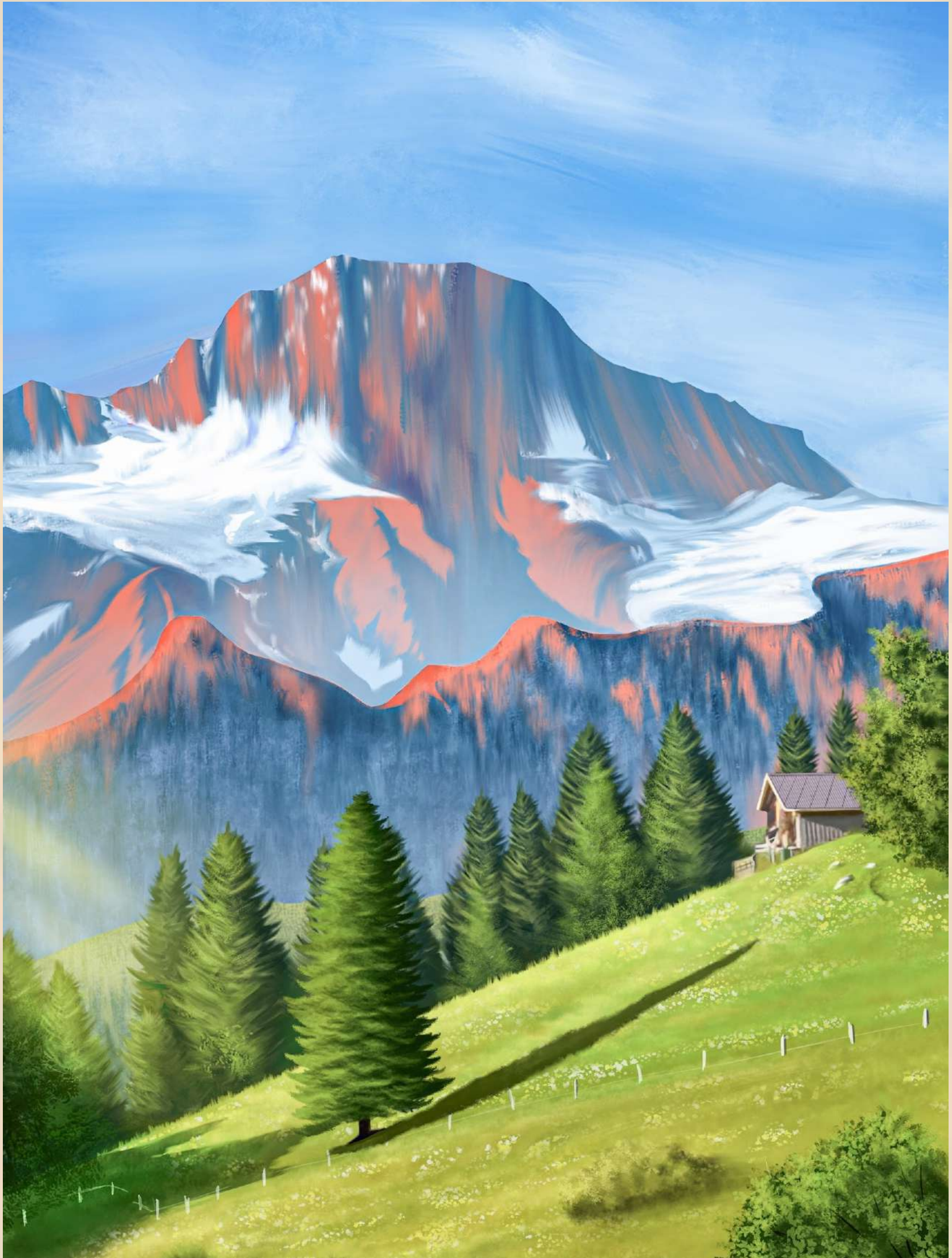
- Arindam Bouri, 3rd year



- Arya Ghosh



- Subhradeep Bose



- Arindam Bouri, 3rd year

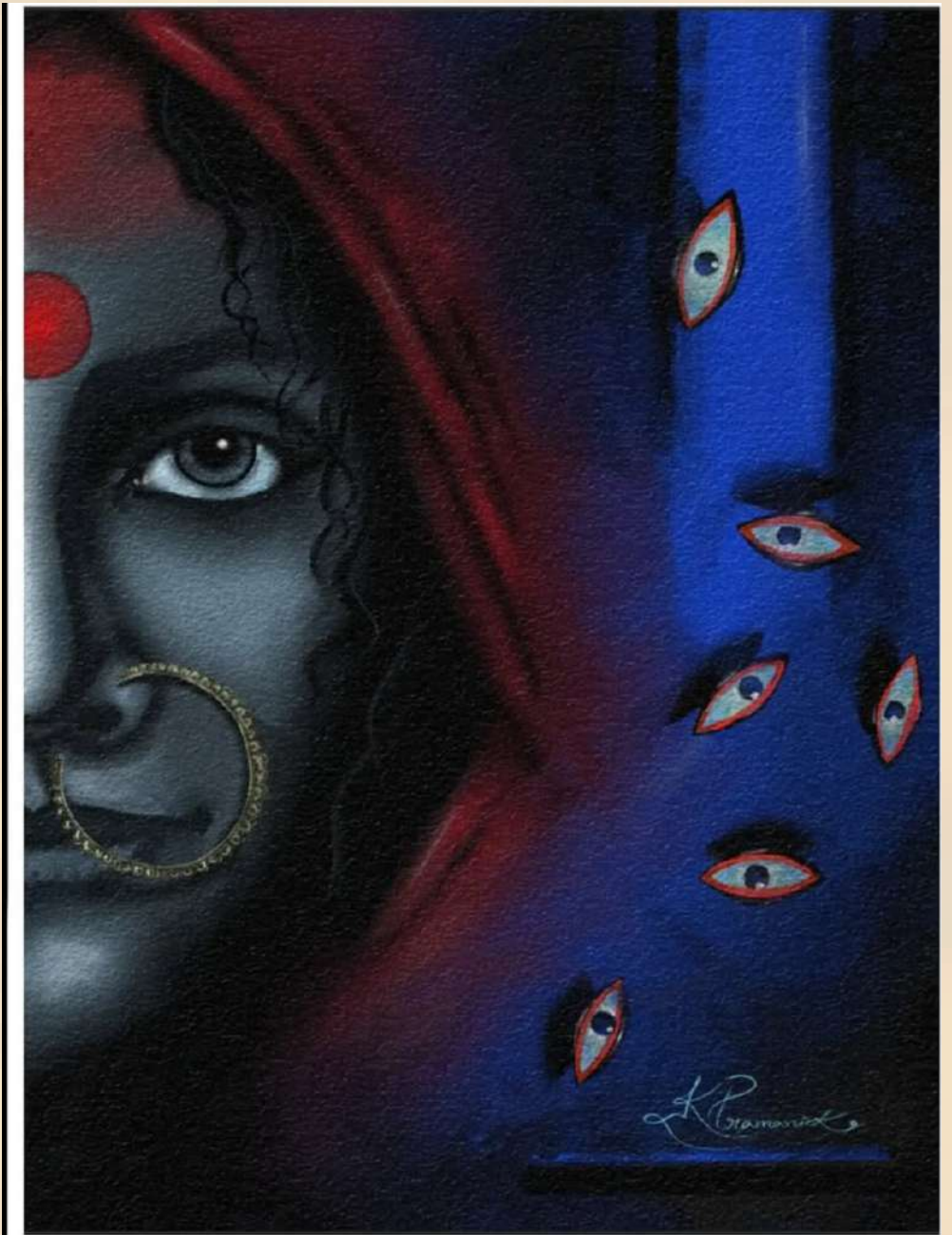
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- Katharoop Pramanick, 3rd Year



- Adrija Karmakar, 2nd Year



- Katharoop Pramanick,
3rd Year



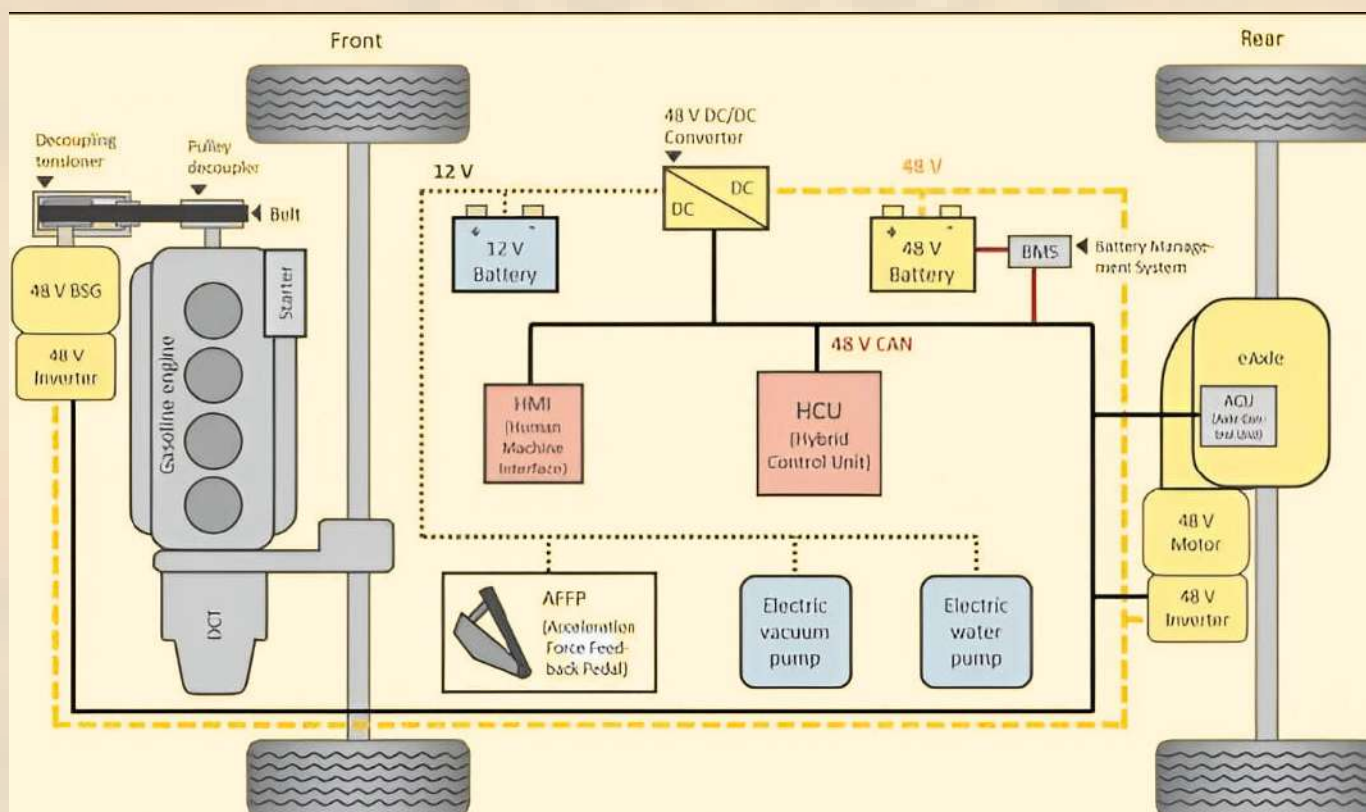
- Arindam Bouri, 3rd year



Electrifying the Future: The Role of Electrical Engineering in EV Revolution

- Aritra Chakraborty, 3rd Year,
Subhayan Dhar, 3rd Year

1. Electrical Heart of the EV: Powertrain & Electronics:



The powertrain is the lifeblood of an electric vehicle, integrating multiple subsystems that convert stored electrical energy into mechanical motion. It includes the traction motor, battery pack, power electronics (inverters, onboard chargers, DC–DC converters), battery management system (BMS), and the vehicle control unit (VCU). Together, these components



I tried to make a joke about *static electricity, but all I got was a **shocking* silence.

ensure efficient energy transfer from the grid or charging station to the wheels.

Traction motors—primarily three-phase AC synchronous motors—are known for their instantaneous torque delivery, superior

efficiency, and reduced maintenance needs compared to combustion engines. They eliminate the need for clutches and complex gearboxes, simplifying vehicle architecture.

Battery technology forms the foundation of EV performance. Lithium-ion chemistries like LiNMC, LFP, and Li-NCA dominate, each offering trade-offs between energy density, lifespan, and cost. In 2023, global production reached nearly 2,000 GWh, with 772 GWh allocated to EVs. Continuous research focuses on enhancing safety, increasing range, and reducing costs.

2. Engineering Statistics: Costs, Range, Infrastructure :

Figure 1: Volume-weighted average lithium-ion battery pack and cell price split, 2013-2023



Source: BloombergNEF. Historical prices have been updated to reflect real 2023 dollars. Weighted average survey value includes 303 data points from passenger cars, buses, commercial vehicles, and stationary storage.

The economics of EVs have dramatically improved over the past decade. Battery costs have plummeted from over \$1,000 per kWh in 2010 to around \$120 in 2023, enabling automakers to

produce EVs at prices competitive with traditional vehicles. This cost reduction is crucial, as batteries account for 30–40% of an EV's total cost.

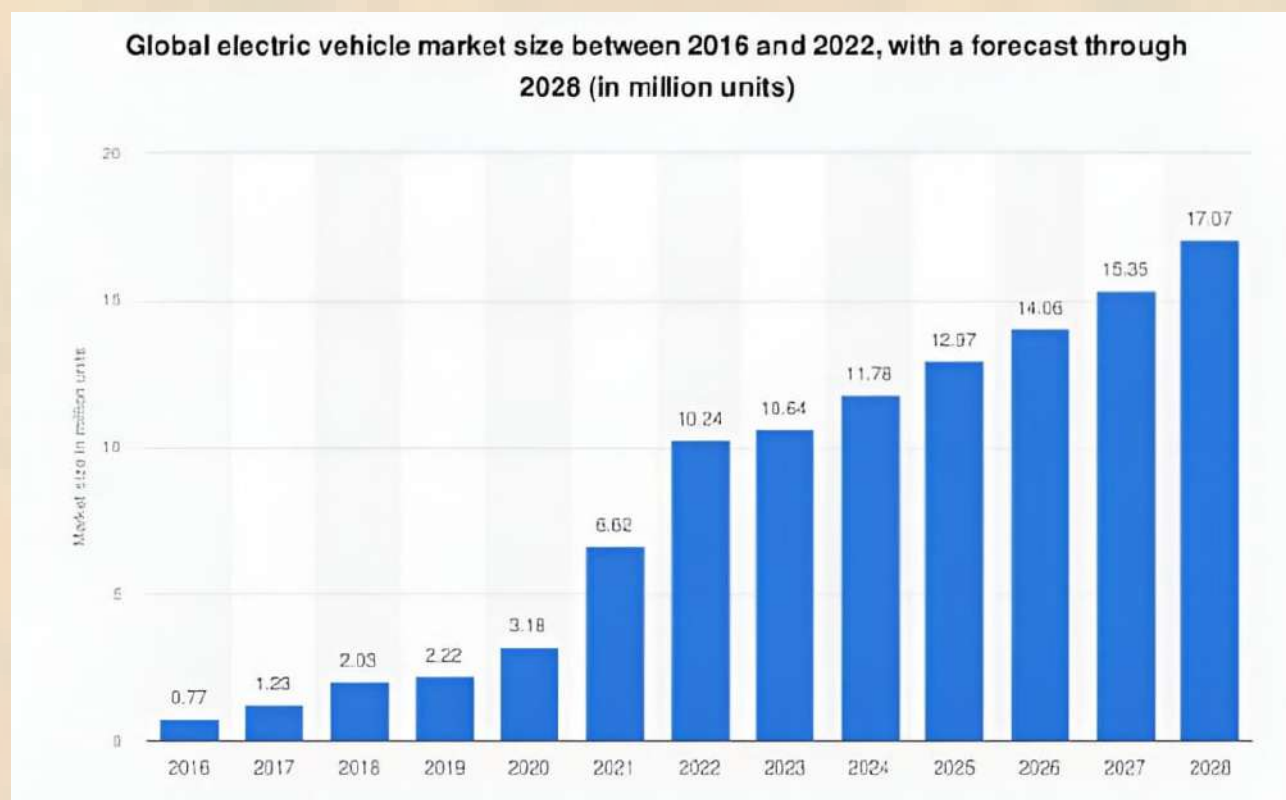


Why did the
light bulb fail
the test?
It wasn't
bright enough

Range—once a major concern—has steadily increased, with the average EV now capable of about 250 miles per charge. Lifespans are also improving, with batteries lasting up to 15 years or 200,000 miles under typical usage.

Infrastructure is equally important. Around 65% of Indian EV owners rely on home charging, but public charging networks are expanding rapidly. Fast chargers can replenish up to 80% of a battery’s capacity in about 30 minutes, reducing downtime and making EVs more practical for long journey.

3. Global EV Pulse: Growth, Market, and Trends:



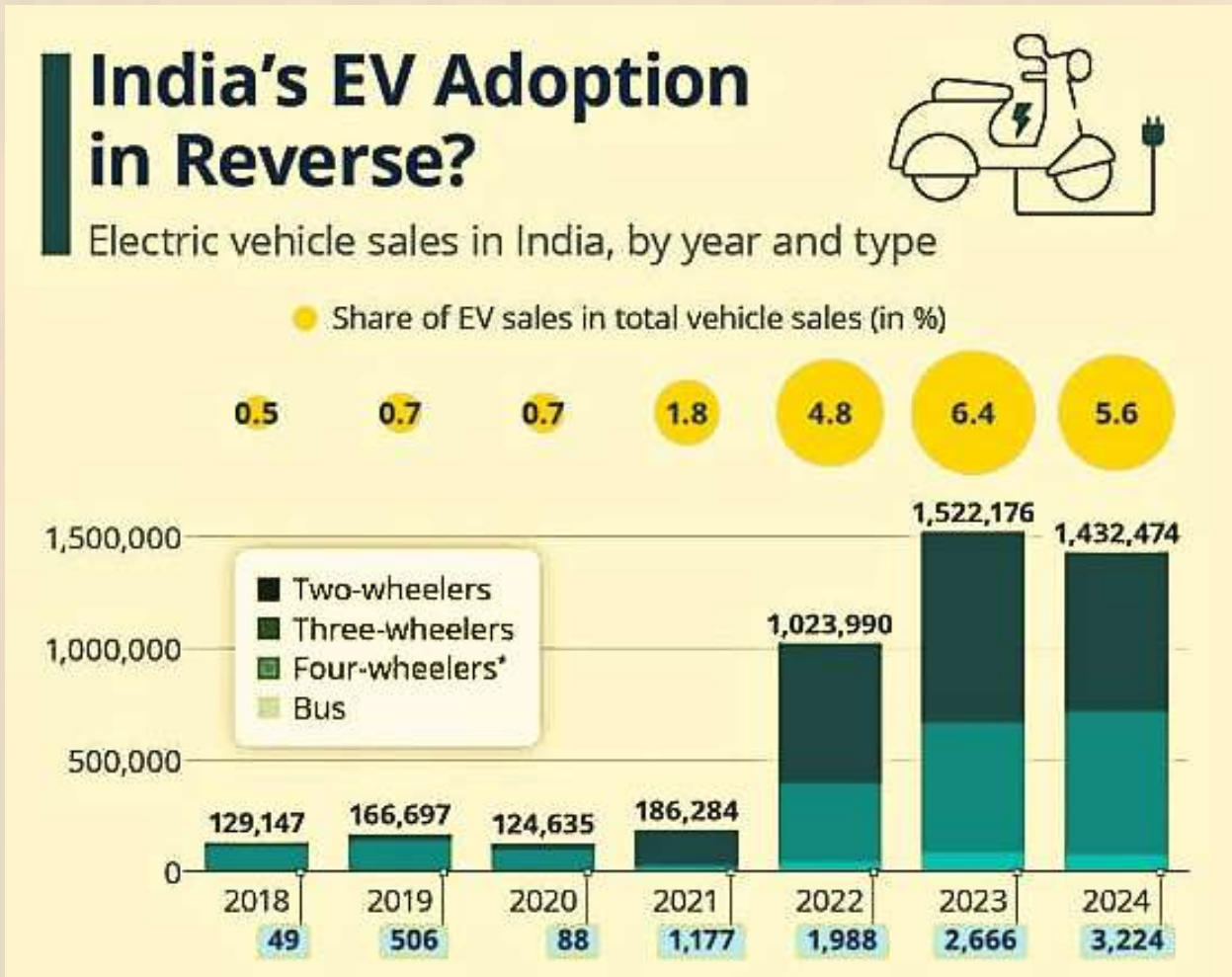
The global EV market, valued at roughly \$350 billion in 2023, is growing at an impressive pace. Electric cars accounted for 21% of all new vehicle sales worldwide, with over 25 million EVs now in operation.

Analysts forecast a compound annual growth rate (CAGR) of around 22% until 2030.

In Q1 2025 alone, more than 4 million EVs were sold, marking a 35% year-on-year increase. China leads the market, followed by Europe and the United States. Projections for 2025 indicate over 20 million units sold, potentially representing a quarter of global car sales.

4. India’s EV Evolution: Statistics & Regional Trends:

India is experiencing a rapid shift toward electric mobility. In FY25, 1.97 million EVs were sold, reflecting a 17% increase from the previous year. Two-wheelers dominate sales with 1.15 million units, driven by affordability and urban commuting needs.

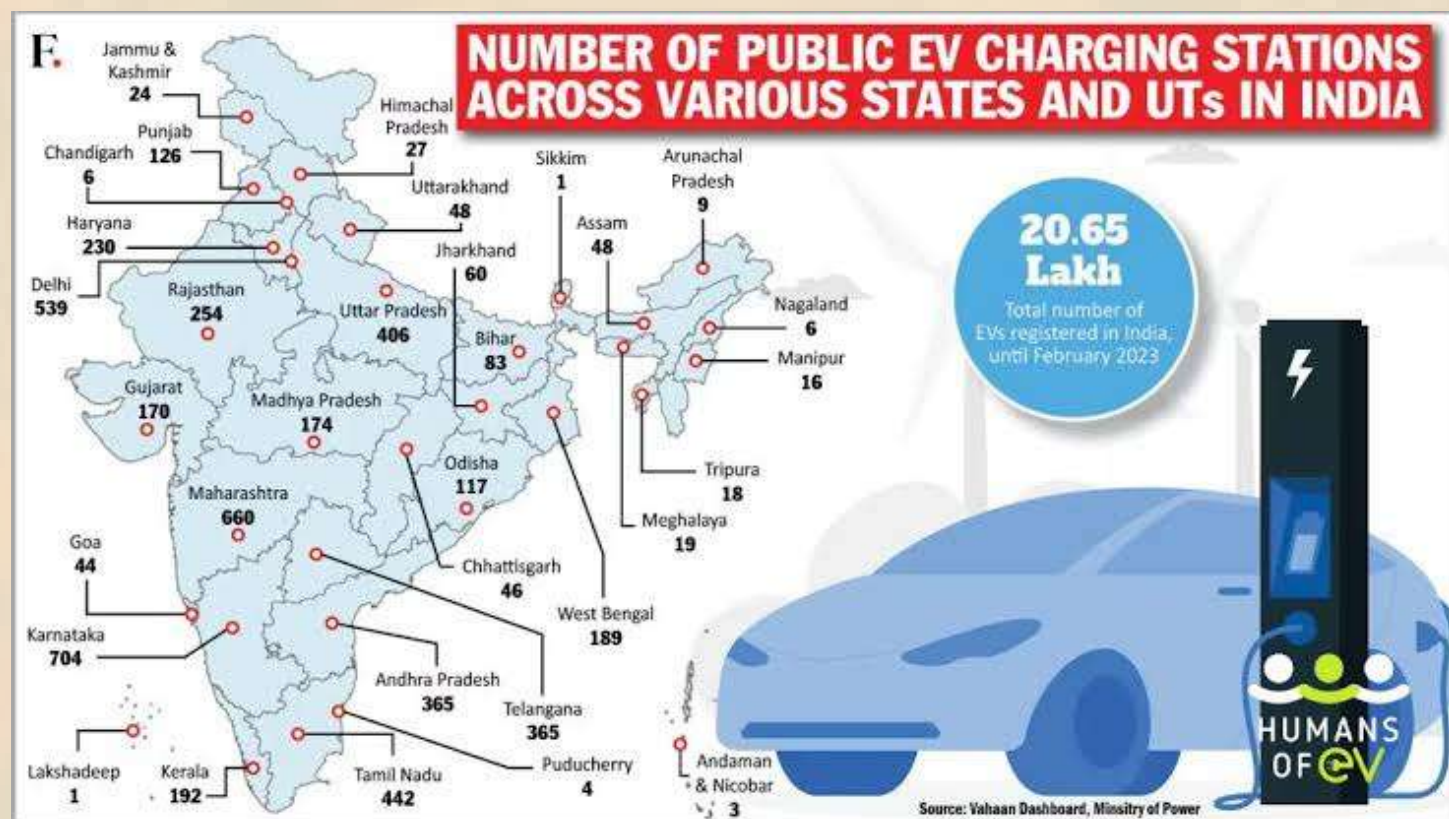


Three-wheelers follow with around 700,000 units, largely used for commercial and public transport.

Electric passenger cars, though still a smaller segment, surpassed 100,000 registrations in FY25. In May 2025, EVs represented 4.1% of all passenger car sales, up from 2.6% the previous year.

Regional adoption varies—Delhi leads with 11.5% penetration, closely followed by Kerala and Guwahati. India's 2030 targets aim for 30% private car adoption, 70% of commercial vehicles, and near-total electrification of two- and three-wheelers.

5. Challenges & Strategic Momentum:

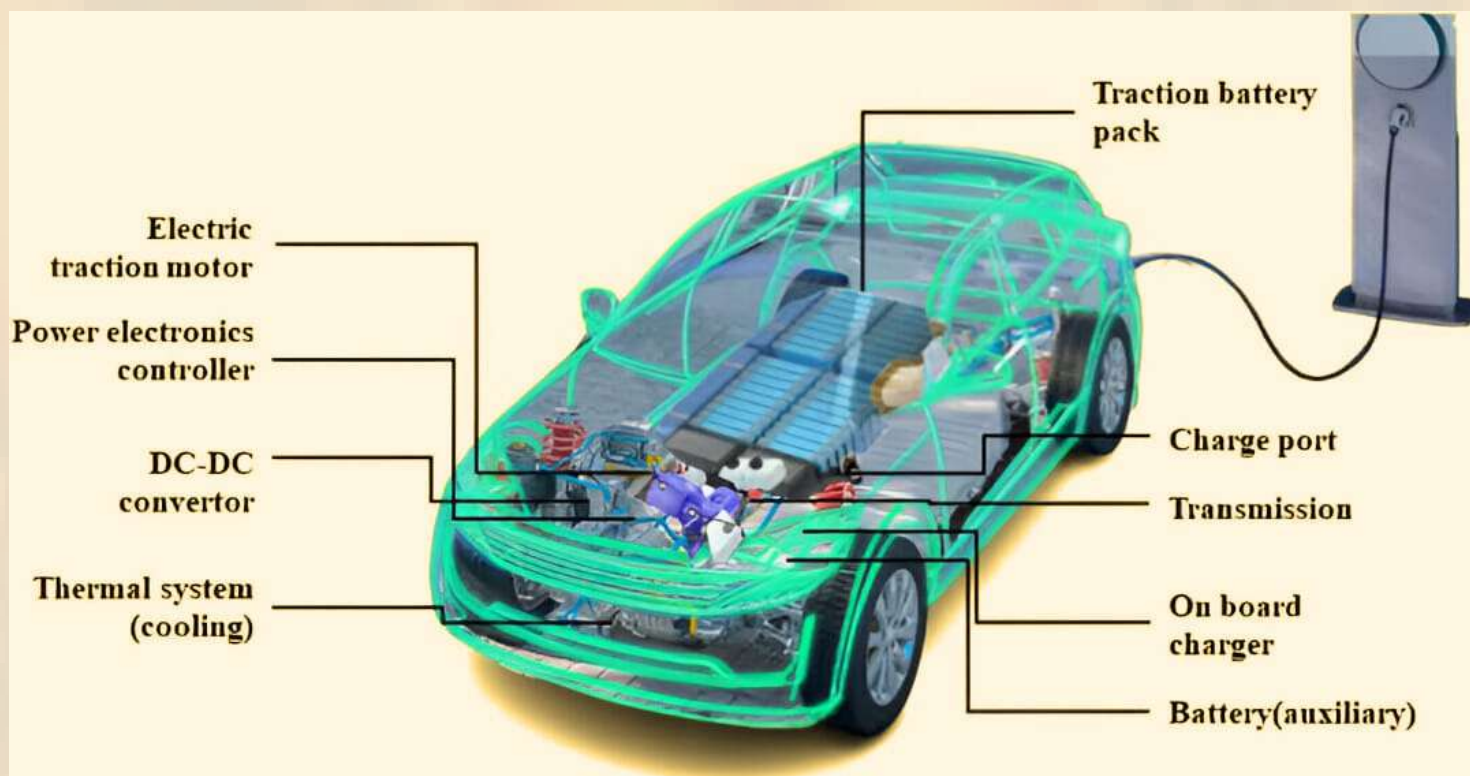


Despite progress, EV adoption faces hurdles. Consumer surveys reveal that while 64% of buyers are open to purchasing an EV, 60% cite insufficient charging infrastructure as a barrier.

In some regions, sales growth has slowed due to reduced subsidies and inadequate charging coverage.

Policy support is essential. For example, Chandigarh is replacing its bus fleet with 328 electric buses under a central scheme. Meanwhile, private companies are investing in ultra-fast charging networks to alleviate range anxiety.

6. The Electrical Engineering Imperative:



Electrical engineering innovations drive the EV revolution. Key focus areas include: - Power electronics: Enhancing inverters and chargers for higher efficiency and faster charging. - Battery R&D: Developing chemistries with better energy density,

thermal stability, and recyclability. - Grid integration: Implementing Vehicle-to-Grid (V2G) systems to allow EVs to serve as energy storage for the grid. - Control systems: Creating intelligent algorithms



What does an electrician call a really bad day?
A *circuit-breaker*!

for battery management, predictive maintenance, and motor control.

These advancements not only improve vehicle performance but also contribute to cleaner, more resilient energy ecosystems.

Conclusion:

Electric vehicles represent a transformative shift in transportation, underpinned by electrical engineering expertise. Falling costs, rising ranges, and expanding infrastructure are accelerating adoption both globally and in India. The coming decade will see engineers at the forefront—innovating in battery technology, charging systems, and energy integration—to ensure EVs are efficient, sustainable, and accessible.

For the next generation of engineers, the EV industry offers a unique opportunity to shape a cleaner, smarter, and more connected world.



Solar EV Charging: A Green Way to Power Cars

- Prof. Sudipta Mitra

Electric vehicles (EVs) are becoming more popular because they help reduce air pollution and the use of fossil fuels. But EVs are only truly clean if they are charged with clean energy. If the electricity comes from coal or oil, the benefit is less. This is why solar-powered EV charging is so important. By using energy from the sun, it offers a renewable, eco-friendly, and low-cost way to power cars.



Solar EV charging works by using solar panels to capture sunlight and turn it into electricity. This electricity can then be used to charge vehicles, stored in batteries for later use, or sent back to the power grid when extra is available. To make the system efficient, special devices like inverters, DC-DC converters, and Maximum Power Point Tracking (MPPT) controllers are used. MPPT

controllers are especially important because they make sure the solar panels always work at their best, even when sunlight is weak or changing. This helps to get 10 – 30% more energy from the panels. An Energy Management System (EMS) is also included to control the flow of power between the panels, batteries, the grid, and the EV.

At home, solar charging usually needs smaller setups. Slow charging (Level 1) provides about 1.4 – 2.4 kW, while faster charging (Level 2) provides 3.3– 7.2 kW, which is enough for daily use. For public stations, the demand is much higher. Level 2 chargers can give up to 22 kW, and DC fast chargers can go from 50 to 350 kW. To support this, commercial solar systems may range from 20 to over 500 kW, often with large batteries to store energy. In public places like parking lots, solar canopies are often built. These provide shade for cars and also generate power. The stored energy can then be used at night, during cloudy weather, or when demand is high. Drivers can also check apps that show how much solar power is used, the charging status, and even how much carbon they are saving.

A new feature that makes solar EV charging even more useful is called Vehicle-to-Grid (V2G). With this technology, EVs can not only take power from the grid but also give power back. For example, during peak hours when many people need

electricity, EVs can send energy stored in their batteries back to the grid. This helps balance supply and demand and may even save money for the car owner. Of course, there are challenges. Solar energy is not always available, especially at night or on cloudy days.

Batteries help, but they are still expensive and limited in size. EV charging times are not always predictable, and too many cars charging at once can put stress on the grid. Also, the cost of installing solar panels, batteries, and charging equipment can be high, and in crowded cities, space for solar panels may be limited. Even with these challenges, the future of solar EV charging looks bright. Solar panels and batteries are getting cheaper every year, and governments are supporting renewable energy projects. Solar powered charging is not just an idea — it is becoming a practical and smart way to power the next generation of transport. With better technology and planning, it will soon become a normal part of our daily lives, helping us move toward a cleaner and greener future.



Sodium-Ion Batteries of the Future: A Potential Lithium-Ion Technology Substitute

- Arya Talukdar, 2nd Year

Overview:

The hunt for lithium-ion battery substitutes has accelerated due to the growing need for energy storage solutions. With a number of benefits over their lithium counterparts, sodium-ion batteries (SIBs) have become a viable alternative. The advantages, difficulties, and prospects of sodium-ion batteries as a next-generation energy storage technology are examined in this article.

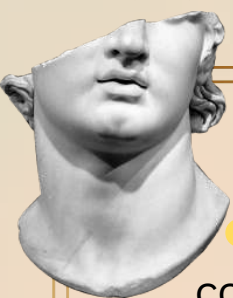
The Argument in Favour of Sodium-Ion Batteries:

1. Cost-effectiveness and abundance:

Since sodium is the sixth most common element in the crust of the Earth, it is much easier to obtain than lithium. Because of this abundance, the cost of raw materials can be reduced, potentially making battery production more affordable. As the need for energy storage grows worldwide, sodium-ion technology's financial benefits become increasingly appealing.

2. Environmental Impact:

Pollution and water depletion are two negative environmental effects that may result from the extraction and processing of lithium. On the other hand, sodium is



Wires
Always better
connected than my
social life.

more sustainably sourced from salt deposits and seawater. It is anticipated that sodium-ion batteries will have a smaller environmental impact, supporting international sustainability objectives.

3. Stability and Safety:

Compared to lithium-ion batteries, sodium-ion batteries have better thermal stability, which lowers the possibility of overheating and fires. For largescale applications where battery failure could have disastrous results, like grid storage and electric vehicles, this safety feature is especially crucial.

Problems with Sodium-Ion Technology:

Not withstanding their benefits, sodium-ion batteries have a number of issues that need to be resolved before they can be

1. Lower Energy Density:

One of the primary drawbacks of sodium-ion batteries is their lower energy density compared to lithium-ion batteries. Because of this, SIBs usually store less energy per unit weight, which may restrict their use in electric vehicles and portable electronics where space and weight are crucial considerations.



Battery Life
 ⚡ Starts positive,
 ends negative, needs
 constant recharging...
 same as me.

2. Cycle Life and Performance:

In comparison to lithium-ion batteries, sodium-ion batteries currently have a shorter cycle life and perform worse at high temperatures. In order to increase the longevity and efficiency of SIBs, research is continuously being conducted to improve the materials used in cathodes and anodes.

3. Technological Maturity:

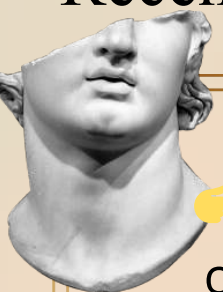
While sodium-ion (Na-ion) batteries have been studied since the 1970s, they are just now becoming commercially viable, similar to the early days of lithium-ion batteries. The technology has moved from lab prototypes to pilot production lines and, in some cases, full-scale manufacturing. This progress is due to improvements in materials science, electrode design, and electrolyte optimization.

- **Current Status:** Several companies, such as CATL, Faradion, HiNa, and Natron Energy, have launched first-generation Na-ion cells. These cells have energy densities of 130–160 Wh/kg, competing with lithium iron phosphate (LFP) batteries in markets like stationary storage and budget EVs.

- **Performance Gaps Closing:** Ongoing research and development are pushing Na-ion batteries towards 200 Wh/kg, offering better cycle life (up to 6,000+ cycles) and fastcharging capabilities. These are critical milestones for widespread EV adoption.
- **Manufacturing Compatibility:** One significant advantage is that Na-ion batteries can be made on existing lithium-ion production lines with little retooling. This speeds up the technology's entry into the market.
- **Commercial Pilots and Scaling:** Industrial-scale deployments are in progress, including CATL's hybrid "AB" packs for EVs, grid-scale storage projects in China, and Reliance's upcoming giga-facility in India.
- **Remaining Challenges:** Despite its promise, sodium-ion technology still faces challenges. It has lower energy density than high-end lithium chemistries, and there is a need for improved supply chains for new cathode and anode materials.

Recent Advancements :

Recent progress in sodium-ion battery technology has shown



Insulators
— The introverts
of electronics —
never let anyone
get close.

promise in tackling some of the challenges mentioned earlier:

1. Innovative Materials:

Researchers are looking into new materials for cathodes, such as sodium manganese oxide and sodium iron phosphate. These materials have shown better performance and stability. Additionally, improvements in anode materials, like hard carbon and sodium titanium phosphate, are being studied to boost energy storage capabilities.

2. Hybrid Systems:

Hybrid battery systems that combine sodium-ion and lithium-ion technologies are being developed. These systems aim to take advantage of the strengths of both types. They can offer a balance between cost, performance, and energy density, making them suitable for different uses.

3. Commercialization Efforts:

Several companies and research institutions are working on commercializing sodiumion batteries. Key players in this area include Faradion, Natron Energy, and CATL. They are developing prototypes and increasing production to meet market needs.



Future Prospects:

The future of sodium-ion batteries looks positive as research continues to progress. With ongoing work to improve energy density, cycle life, and overall performance, SIBs could become a suitable alternative to lithium-ion batteries in various uses. Their potential for large-scale energy storage, especially in renewable energy systems, positions them as an important part of the shift to a sustainable energy future.

Conclusion:

Sodium-ion batteries mark a major advancement in energy storage technology. Due to their abundance, cost-effectiveness, and safety benefits, they could replace lithium-ion batteries in many applications. While there are challenges ahead, ongoing research and development are clearing the way for the commercialization of sodium-ion technology. As we strive for a more sustainable future, sodium-ion batteries could be vital in meeting the world's energy storage needs.



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Durga puja and Bengali

Durga puja and Bengali

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PHOTOGRAPHY BY

*SAYANDIP
MONDAL*

EE | 2ND YEAR

শারদীয় দুর্গাপূজা বাঙালির প্রাণের উৎসব, যা শুধুমাত্র একটি ধর্মীয় উৎসব নয়। এই পূজা বাঙালি জীবনের সবথেকে বড়ো সামাজিক ও সাংস্কৃতিক উৎসব। নীল আকাশে সাদা মেঘের ভেলা, কাশ ফুল, শিউলি ফুলের গন্ধ জানিয়ে দিয়ে যায় আগমনীর খবর।

পৌরাণিক কাহিনী অনুসারে মহিষাসুর নামে এক অসুরকে বধ করে সৃষ্টিকে রক্ষা করার জন্য দেবতাদের সম্মিলিত শক্তির থেকে জন্ম নেন মা দুর্গা, দশ হস্ত বিশিষ্ট দেবী। দশ হাতে অস্ত্র ধরে তিনি সংসার করেন মহিষাসুরকে।

অসুরী শক্তি বিনাশ ও শুভ শক্তির সূচনা কে স্মরণ করেই এই উৎসব পালিত হয় আপামর বাঙালির ঘরে ঘরে।

নদীয়ার রাজা কৃষ্ণচন্দ্র রায় বাংলায় প্রথম এই উৎসবের সূচনা করেন। পরে কোলকাতার বিভিন্ন জমিদার পরিবার এই উৎসবকে জনপ্রিয় করে তুলতে অগ্রণী ভূমিকা গ্রহণ করেন।

মহালয়ার মধ্য দিয়ে সূচনা হয় এই উৎসবের। এরপর ষষ্ঠী, সপ্তমী, অষ্টমী, নবমী মহাসমারোহে পালিত হয় এই উৎসব। দশমীতে বিষন্ন মনে মায়ের বিদায় ও সিঁদুর খেলা। তার পর চলতে থাকে বিজয়া দশমীর অনুষ্ঠান। ছোটরা বড়োদের প্রণাম করে শ্রদ্ধা নিবেদন করে। বড়োরাও ছোটদের আশির্বাদ করে মঙ্গল কামনা করেন। চলে মিষ্টিমুখের পালা।

শারদীয়া দুর্গোৎসব বাঙালী জনজীবনের সবথেকে বড় মিলন মেলা। ধর্মের সীমা ছাড়িয়ে এই উৎসব সকলকে শেখায় ভালোবাসা, সম্প্রীতি ও একতার মন্ত্র। উৎসবের কয়টা দিন সব দুঃখ কষ্ট ভুলে সবাই উৎসবের আনন্দে মেতে ওঠে। দেশীয় অর্থনীতিতেও এর বিশেষ প্রভাব লক্ষ্য করা যায়। বিভিন্ন শিল্পের সাথে যুক্ত মানুষের আয়ের পথ তৈরী করে এই উৎসব। এই উৎসবের সামাজিক, অর্থনৈতিক ও শৈল্পিক গুরুত্বকে মাথার রেখে ২০২১ সালে ইউনেস্কোর তরফ থেকে এটিকে হেরিটেজ ঘোষণা করা হয়েছে।

তাই তো আমরা প্রতি বছর প্রার্থনা করি - " **আবার এসো মা, আবার এসো।**"

-Arya Talukdar, 2nd year

দুর্গাপূজা বাঙালির শ্রেষ্ঠ উৎসব। শরৎকালের নীল আকাশ, কাশফুল আর হাওয়ার মিষ্টি ছোঁয়ায় পূজার আমেজ শুরু হয়। দেবী দুর্গা মহিষাসুরমর্দিনী রূপে আবির্ভূত হন, সত্যের জয় ও অসুরের বিনাশের প্রতীক হয়ে। চার দিন ধরে গ্রাম থেকে শহর—সবখানেই আনন্দের ঢেউ ওঠে। আলোকসজ্জায় সেজে ওঠে প্যান্ডেল, প্রতিমায় ফুটে ওঠে শিল্পীর কল্পনা।

এই সময়ে নতুন জামা, ভোগপ্রসাদ আর ঢাকের আওয়াজে মুখরিত হয় চারপাশ। সকালে অঞ্জলি দেওয়া, বিকেলে ঠাকুর দেখা, আর সন্ধ্যায় বন্ধুদের সঙ্গে প্যান্ডেল হপিং—সবকিছু মিলেই পূজা হয় আরও আনন্দময়। রাস্তার ভিড়ে একসাথে হাসি-ঠাট্টা, ছবি তোলা আর নতুন নতুন মণ্ডপ দেখা—এ যেন এক অবিস্মরণীয় অভিজ্ঞতা। বিজয়া দশমীতে মা দুর্গাকে বিদায় জানাতে মন ভরে যায় কষ্টে, তবু থাকে পরের বছরের অপেক্ষা। তাই দুর্গাপূজা শুধু ধর্মীয় উৎসব নয়, এটি বাঙালির প্রাণের আনন্দ, ঐক্য আর সংস্কৃতির প্রতীক।

-Uday Ray Barman, 3rd year



Turning Motion into Energy: Exploring the Working Modes of Triboelectric Nanogenerators

- Prof. Suvabrata Sil

The continuous demand for portable, sustainable, and self-powered electronics has accelerated research in energy harvesting technologies. Among these, Triboelectric Nanogenerators (TENGs) have emerged as a promising solution. A TENG is an energy harvesting device that converts ambient mechanical energy into electricity. It can convert small-scale mechanical energy from the environment, such as vibrations, human motion, or airflow, into useful electrical signals. The TENG operates based on two fundamental physical phenomena, contact electrification, which generates surface charges when different materials come into contact, and electrostatic induction, which drives the movement of charges under the influence of an electric field.

Triboelectric effect is a physical phenomenon by which two dissimilar uncharged materials become electrically charged after they are brought into contact with each other and then separated. One of the two materials always gain electrons,

hence become negatively charged and the other lose electrons, hence become positively charged during the friction between the two materials.



Why don't resistors ever argue?

A: Because they always know their limits.

The polarity and strength of charge generated on the surface of materials depends on the type of the material, roughness of the surface, temperature, strain and other properties. The list that positions materials as per their propensity to lose or acquire electrons is known as the triboelectric series. The relative position of different tribo-active materials is listed in triboelectric series and presented as Fig. 1. The order of a pair of materials in the list indicates their relative tendency to lose or gain electrons when rubbed against each other. When a material towards the top of the triboelectric series is brought into contact with a material towards the bottom of the series, the material at the top of the triboelectric series will gain more positive charge whereas the material towards the bottom of the series will gain more negative charge. The furthest located materials in the triboelectric series when rubbed with each other will cause greater charge transfer. Depending on the relative movement and configuration of their components, TENGs can work in four fundamental modes: contact–separation (CS) mode, lateral sliding (LS) mode, single-electrode (SE) mode, and freestanding triboelectric-layer (FT) mode.



What's a capacitor's favorite job?

A: Storage management.

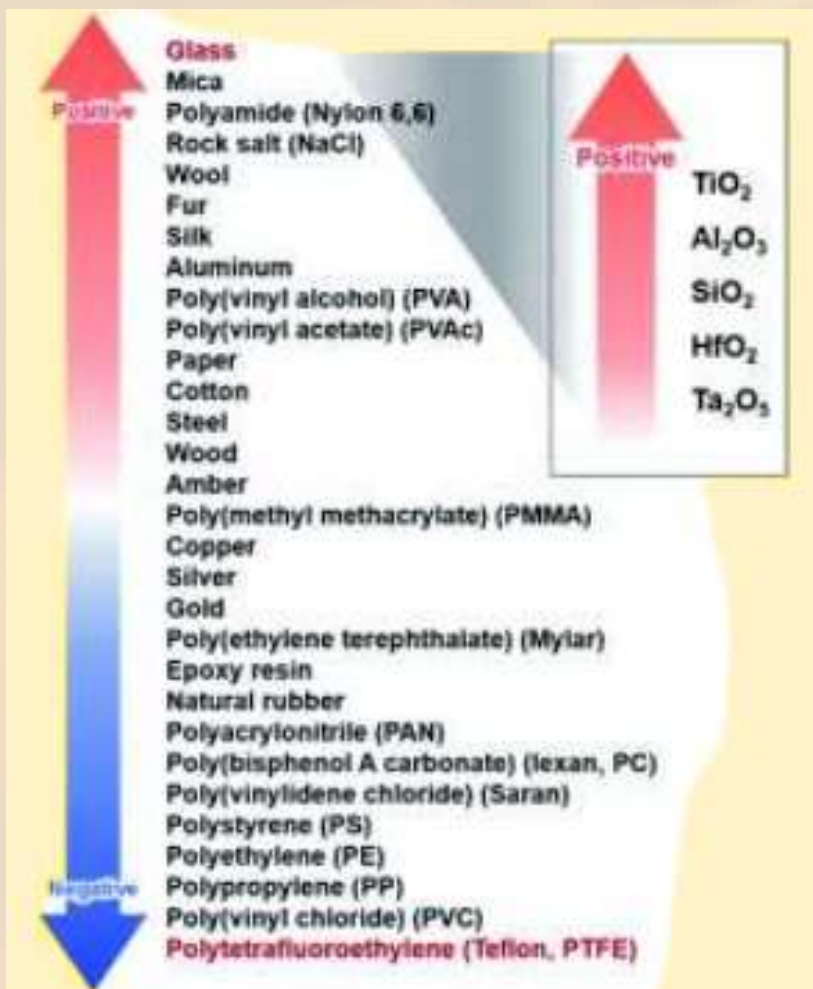


Fig. 1. A conventional triboelectric series and an experimentally determined triboelectric series of oxide dielectric materials.

2. Working Modes of TENG:

2.1. Contact Separation Mode:

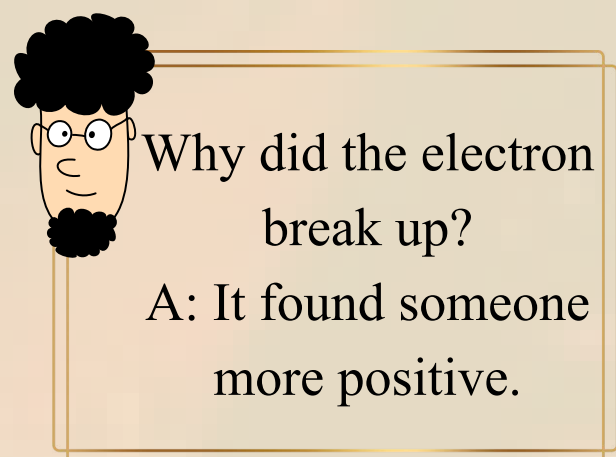
In CS mode, two triboelectric layers with different electron affinities are repeatedly brought into contact and then separated. When they touch, charges are exchanged between the surfaces. Upon separation, this difference in surface charges creates an electric potential, which drives electrons to flow through the external circuit. The process repeats with each cycle of contact and release, producing alternating current. The

structure is conceptually simple and easy to fabricate, making it the most basic TENG design. A practical application of this mode is in vibration energy harvesting devices, where ambient mechanical shocks,

Why was the circuit sad?

A: Too much resistance in its life.

footsteps, or even typing motions can generate electricity. It is also used in impact sensors that require real-time detection of contact forces. Fig. 2. presents a detailed explanation of the CS working mechanism of a TENG. At the initial stage, when the two surfaces remain separated, neither charge generation nor induction occurs because there is no interaction between the materials (Fig. 2 I). Once the surfaces come into contact, triboelectric charges are formed on their interfaces as a result of the difference in electron affinities of the two materials (Fig. 2 II). When the surfaces are subsequently pulled apart, the separation of these oppositely charged surfaces creates an electric potential difference between the electrodes. This potential difference forces electrons to flow from the bottom electrode toward the top electrode through the external circuit until an electrostatic equilibrium is reached, corresponding to the fully separated state (Fig. 2 III–IV). When the two surfaces are brought into contact again, the potential difference is reversed, causing the induced charges to flow back in the opposite direction through the external circuit to neutralize the imbalance (Fig. 2 V). This alternating process of contact and separation generates a periodic current, the waveform of which is depicted in the top right corner of Fig. 2.



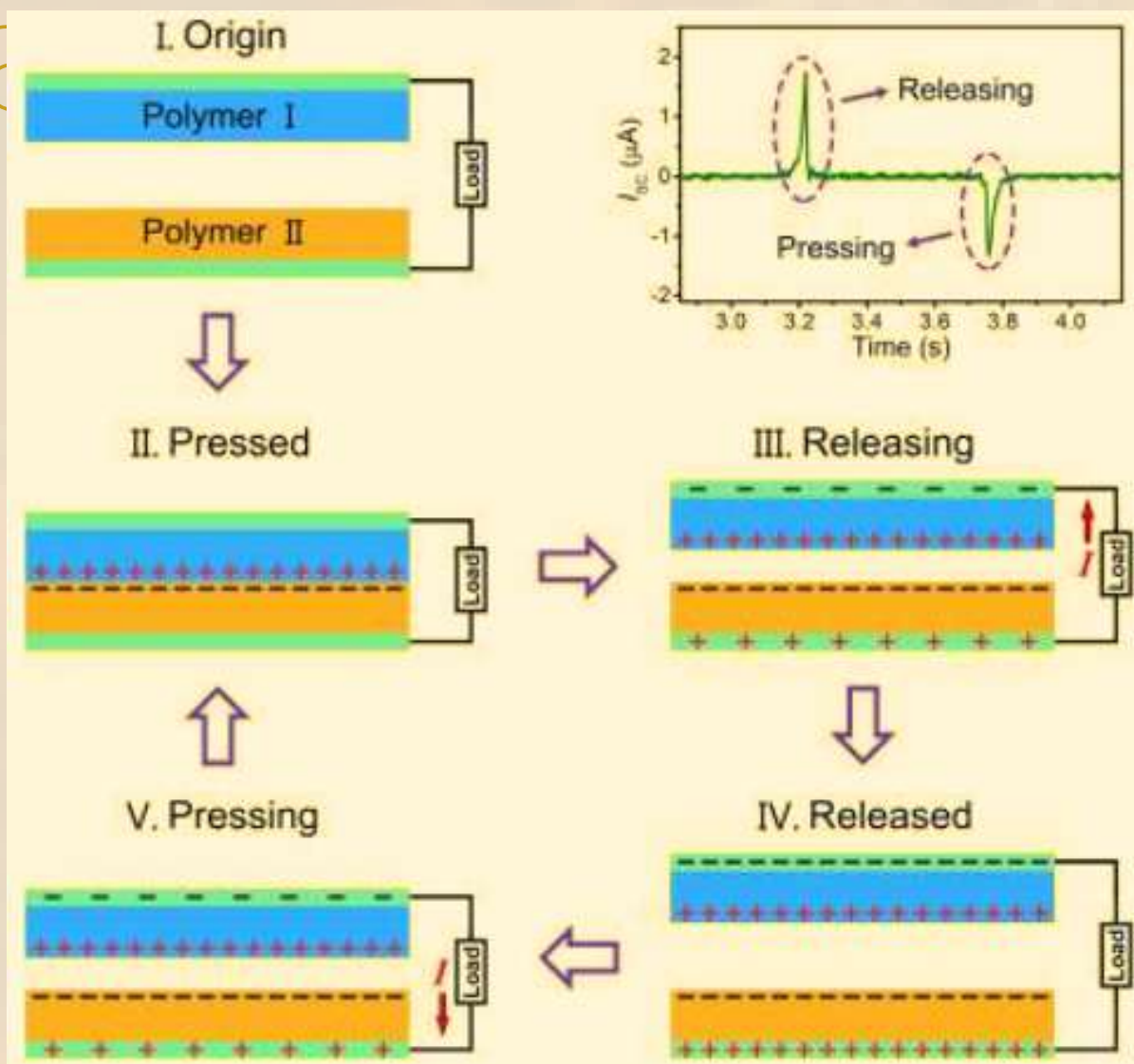


Fig. 2. Illustrations showing the working principle of a TENG operating under the contact separation mode.

2.2. Lateral Sliding Mode:

Unlike the vertical motion in CS mode, this configuration relies on sideways sliding between two triboelectric surfaces. As the materials slide relative to each other, the effective overlapping area changes, which alters the distribution of triboelectric charges. This results in a continuous flow of current as the sliding progresses back and forth. One of the strengths of this mode is that it can generate electricity more efficiently

under continuous motion compared to intermittent contact. It is particularly useful in wearable devices that monitor body movement, and in rotary energy harvesters, where the sliding motion can

Why don't insulators gossip?

A: Because nothing flows through them.

be harnessed from wheels, gears, or rotating machinery. Fig. 3(a) depicts the working mechanism of the LS mode. In LS mode a relative displacement between the two dielectric layers A & B parallel to the contact surface is applied and utilized for example harvesting. The potential changes between the two electrodes C and thus electric output are generated through the external circuit D.

2.3. Single Electrode Mode:

The single-electrode mode offers the simplest design because it requires only one electrode connected to the triboelectric material, while the environment or another free-moving object serves as the second “virtual” electrode. As the external object approaches or moves away from the triboelectric layer, charge redistribution occurs, creating current flow relative to the ground. This mode is highly versatile because it does not require the moving object to be permanently attached to the device. It is especially advantageous for applications like touchsensitive interfaces, gesture recognition systems, and wearable human–machine interaction devices, where the TENG can harvest energy from human skin or other natural

interactions without restricting movement. Fig. 3(c) illustrates the working of the SE mode. In SE TENG ground is used as reference electrode as shown in Fig. 3(c). In SE mode the only



What's an
electrician's favorite
dating advice?
A: Find your perfect
match and make
sparks fly.

electrode B is grounded through an external load C. The triboelectric layer A can uninhibitedly move without appending an electric association. When layer A intermittently proceed towards and departs from the stationary electrode B on application of horizontal or vertical forces, transfer of free electrons take place between the electrode C and ground through external circuit.

2.4. Freestanding Triboelectric Layer Mode:

In this advanced configuration, a triboelectric layer carrying surface charges is allowed to move freely between two stationary electrodes. As the charged layer moves, it induces a potential difference between the electrodes due to electrostatic induction. Current then flows alternately between the electrodes as the position of the layer changes. Importantly, this mode does not require the free layer to make direct electrical contact with the electrodes, which reduces wear and improves durability. It is well suited for airflow-driven devices, rotational energy harvesters, and motion sensors, where the free movement of the charged material can be driven by wind, fluid, or mechanical rotation. Fig. 3(d) shows the



Why do fuses never grow old?

A: Because they blow at a young age.

working of the FT layer mode. In FT layer mode [6] displayed in Fig. 3(d), a pair of symmetric electrodes B are used instead of using ground as reference electrode as in case of a SE mode TENG.

The pair of

symmetric electrodes are kept moderately fixed and are coupled to each other through a load C. When the freestanding dielectric layer A maneuvers between the two electrodes, an uneven charge dissemination is produced through induction, which results in transfer of charge between the two electrodes via the external load C.

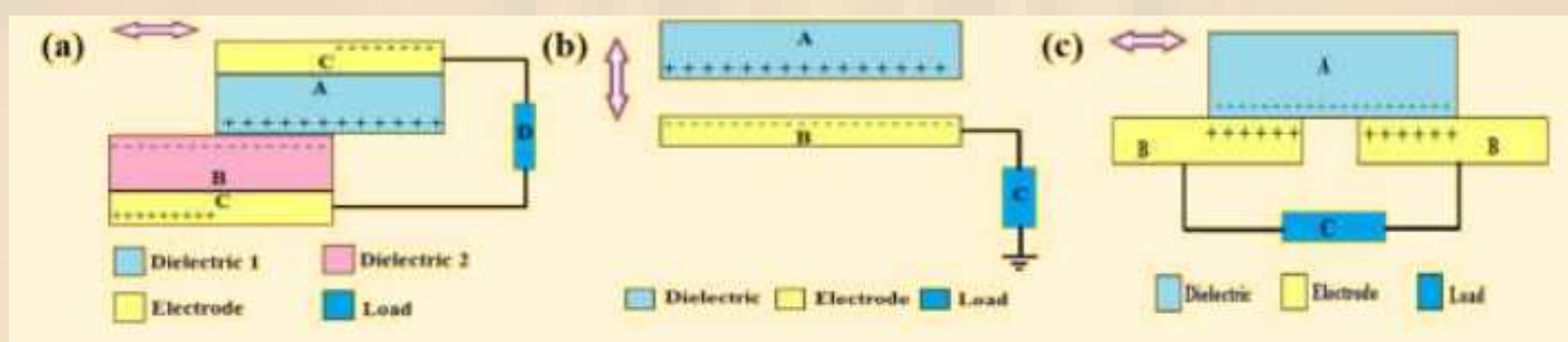


Fig. 3. The working modes of TENG. (a) Lateral sliding mode, (b) Single-electrode mode, and (c) Freestanding triboelectric-layer mode.

3. Conclusion:

Triboelectric Nanogenerators represent a simple yet powerful technology that can harvest energy from everyday mechanical activities. The CS mode provides the simplest structure for vibration-based harvesting, while the LS mode is effective for continuous motion. The SE mode enables flexible interactions with the environment, and the FT layer mode allows for non-contact energy harvesting with enhanced durability. Together, these modes expand the potential of TENGs for powering small

electronic devices, enabling self-sustained sensors, and paving the way toward smarter, greener technologies. For undergraduate students, learning about these modes provides not only insight into a fascinating energy conversion principle but also inspiration for innovative applications in future electronics.



One day, a capacitor walked into a party.

Everyone said, “Hey, why so quiet?”

The capacitor replied, “I’m just here to store the energy.”

A resistor yelled back, “Don’t bottle it up too much, or you’ll explode!”

The inductor chimed in, “Relax, I’ll keep things steady.”

Meanwhile, the battery sighed: “Great... now I’m the one drained.”

Space-Based Solar Power: Stealing Sunlight... From Space

- Subhadeep Chanda, 2nd Year

Giant solar panels floating in orbit, soaking up sunlight 24/7, and beaming it directly into homes may have seemed like a utopian future at best. With newer technology and scientific breakthroughs such as SBSP, this is no longer a figment of imagination. Space-Based Solar Power (SBSP) is a renewable energy source previously deemed unimaginable. Pure, unfiltered energy, sourced directly from the sun, acts as the guiding proponent to the new age power systems in an average household.

Working Principle:

Massive solar arrays orbit high above Earth which catch oncoming sunlight in its entirety (no atmosphere to absorb any of the energy). The electricity thus produced from this solar energy is converted into microwaves or lasers. Those beams get aimed at giant receiving antennas on Earth, which turn it back into electricity which is responsible for lighting up cities.

Solution:

Previously, SBSP (Space Based Solar Power) was an idea conceptualised only in sci-fi novels because launching massive panels was an expensive and



Why did the transformer go to therapy?

A: It had identity issues with stepping up and stepping down.

arduous affair. Microwave beaming technology was still under works and space machinery was not equipped to adequately handle the load. With the addition of sophisticated technology like smarter and more precise microwave and laser systems, cheaper rocket launches are possible thanks to reusable boosters.

Advantages of SBSP:

- i) 24/7 clean energy
- ii) Anywhere delivery: Remote villages or even disaster zones
- iii) Less storage needed: Continuous supply means smaller battery banks.

Some unknown facts:

- Sunlight in space has higher radiant flux ($\sim 1,366 \text{ W/m}^2$) as compared to the same on Earth ($\sim 1,000 \text{ W/m}^2$).
- GEO (Geostationary Orbit) satellites can beam power to the same spot all day.
- Microwaves are tuned to safe frequencies so they won't roast birds or your food.



What did AC say to DC?

A: "Stop being so straightforward."

The Future:

Japan, Europe, China, and the USA are all part of the SBSP race. Projects on the horizon include, but are not limited to:

- i) Orbital test satellites
- ii) Gigawatt-scale power stations
- iii) Wireless EV charging on the go

Space-Based Solar Power (SBSP) therefore presents a bold and innovative approach to addressing the world's growing energy demands and the urgent need for clean, renewable power sources. By capturing solar energy in space to transmit onto Earth, SBSP could potentially provide a continuous and reliable energy supply on a global scale. While the concept is scientifically sound and technologically promising, significant challenges remain, including:

- i) High launch costs
- ii) Energy transmission efficiency
- iii) Satellite maintenance
- iv) Space debris risks



Why do switches love drama?

A: They're either fully ON or totally OFF.

However, ongoing advancements in wireless power transmission, modular satellite design, and reusable launch systems are steadily improving SBSP's feasibility. With such obstacles overcome, SBSP could potentially become a transformative component of the future energy mix: enhancing energy security, reducing dependence on fossil fuels, and contributing significantly to global decarbonization efforts.



Interviewer: "So, Mr. Current, what makes you unique?"

Electricity: "I flow naturally wherever I go."

Interviewer: "Any weaknesses?"

Electricity: "Yeah... high resistance really slows me down."

Interviewer: "What about teamwork?"

Electricity: "In parallel, I shine. In series, I suffer."

HR Manager: "Hired! You're truly shocking."

Piezoelectric Tiles in Japan – A Step Towards The Future of Sustainable Energy

- Deepangshu Halder, 2nd Year

As global cities strive toward sustainable development, innovative micro-generation technologies are reshaping how we capture and utilize energy. One such advancement is the integration of Piezoelectric Tiles—smart flooring systems that convert mechanical stress from foot traffic into electrical energy. Japan, particularly Tokyo, has emerged as a global leader in deploying this technology, embedding it within high-traffic urban areas to harness kinetic energy from daily pedestrian movement. This article explores the science behind piezoelectricity and examines how Japan's implementation of these tiles represents a forwardthinking model for renewable energy integration in modern infrastructure. This technology offers a sustainable, eco-friendly, and low-maintenance energy solution.

Understanding Piezoelectricity:

The foundation of this innovation lies in the piezoelectric effect, first discovered by Jacques and Pierre Curie in 1880. Certain materials—primarily ceramics such as lead Zirconate titanate (PZT) and natural crystals like quartz—generate an electrical charge



Why did the diode go on a self-help course?

A: To learn how to block the negatives.

when subjected to mechanical stress. The term "piezo" originates from the Greek word piezein, meaning “to press”.

Mathematically, the piezoelectric effect can be expressed as:

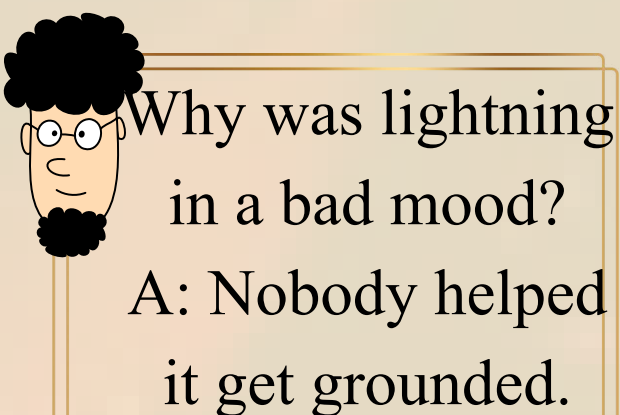
$$D = d \cdot T + \epsilon \cdot E$$

Where: D = electric displacement, d = piezoelectric coefficient (material-dependent), T = mechanical stress, ϵ = permittivity, E = electric field

This direct piezoelectric effect is harnessed in piezoelectric tiles by embedding materials that deform under human footfall, converting mechanical strain into electric energy.

Implementation in Japan: A Technological Leap:

In 2008, Japan initiated pilot projects under the Tokyo Metropolitan Government's green energy campaign, testing piezoelectric floor tiles in Shibuya Station—one of the busiest train stations globally, serving over 2.4 million passengers daily. Developed by companies like Sound power Corp. and Panasonic, these tiles consist of multi-layered piezoceramic sheets sandwiched between flexible electrodes and dampening layers.



Operational Dynamics:

1. Step/Pressure is applied on the tile.
2. Piezoelectric material deforms and generates a small voltage.
3. This voltage is rectified and stored in capacitors or batteries.
4. Stored power is used for LED lighting, sign boards, temperature sensors, or fed into the local micro grid.
5. One footstep can generate approximately 5 to 7 watts for a fraction of a second, enough to power an LED bulb for several seconds.

Real-World Applications in Tokyo:

1. Narita Airport: Tiles at key junctions help power interactive displays.
2. Shibuya and Tokyo Station: Powering digital signboards and ticket gates.
3. Eco-Kanagawa Smart House (2012): Piezoelectric floors in residential environments.
4. Stadiums and Walkways: Installed during public events to educate the public and reduce event carbon footprints.

Piezoelectric energy is part of the larger Energy Harvesting domain, which includes solar, wind, and thermoelectric sources. While not a primary power source, it supports the Internet of Things (IoT) by powering low-energy sensors, smart infrastructure, and

wearable electronics.

Japan's success demonstrates how urban kinetic energy—typically wasted—can be reclaimed in high-footfall areas like train stations, airports, and shopping malls. As material science advances, nanostructured piezoelectric materials are being explored to improve output and durability

Global Influence and Future Prospects:

1. Inspired by Japan, several other countries have adopted similar strategies.
2. The Netherlands: Dance floors converting dance energy into electricity (Rotterdam).
3. UK: Pavement tiles by Pavegen in London and airports.
4. India (2022): Pilot tests in Mumbai and Hyderabad railway stations.



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Lens
time



**By Anuska Roy,
2nd year**



**By Aditya Raj,
3rd year**



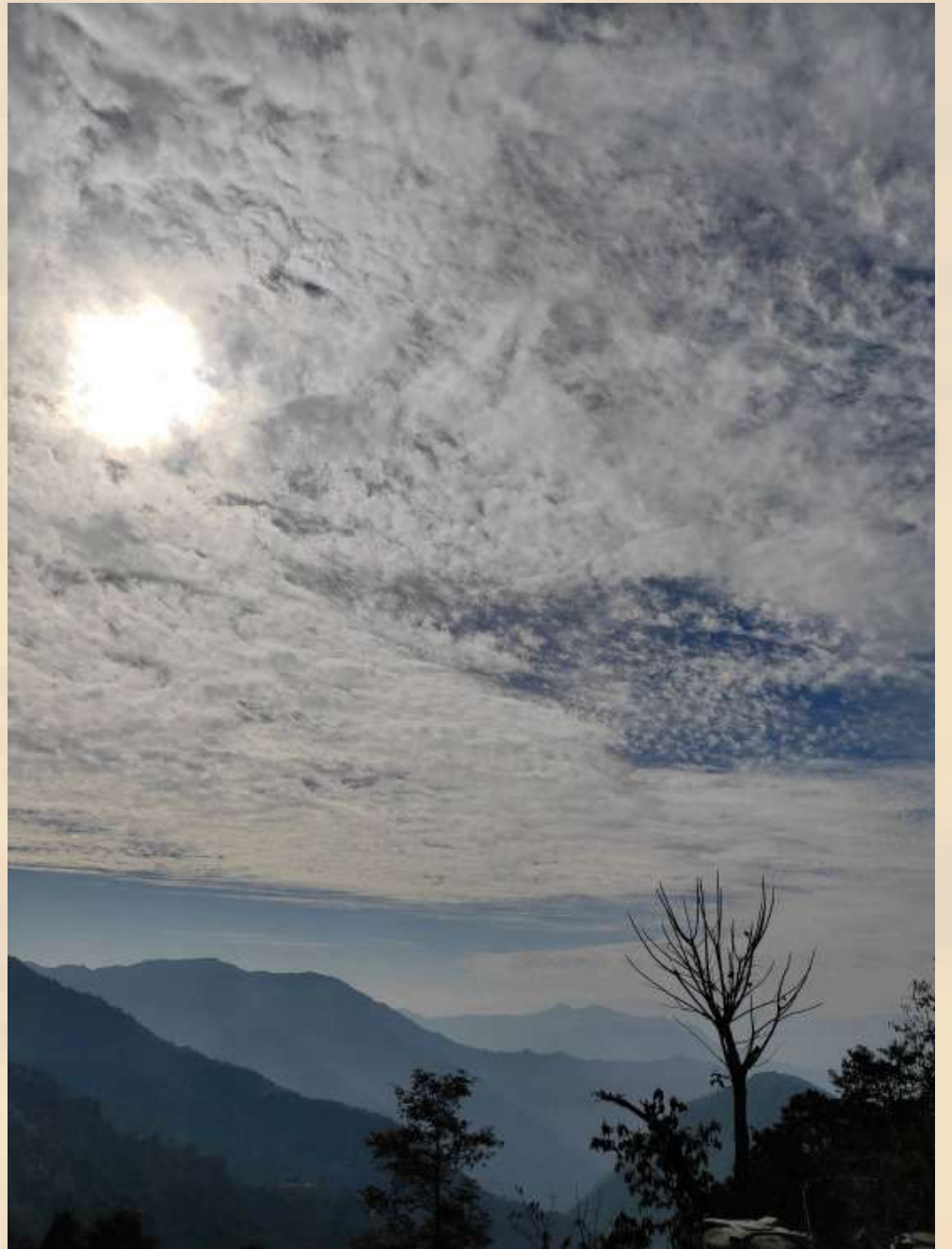
By Aditya Raj, 3rd Year



By Rohit Das, 3rd Year



**By Akshita Chakraborty,
3rd Year**



**By Rupantar Banerjee,
2nd Year**

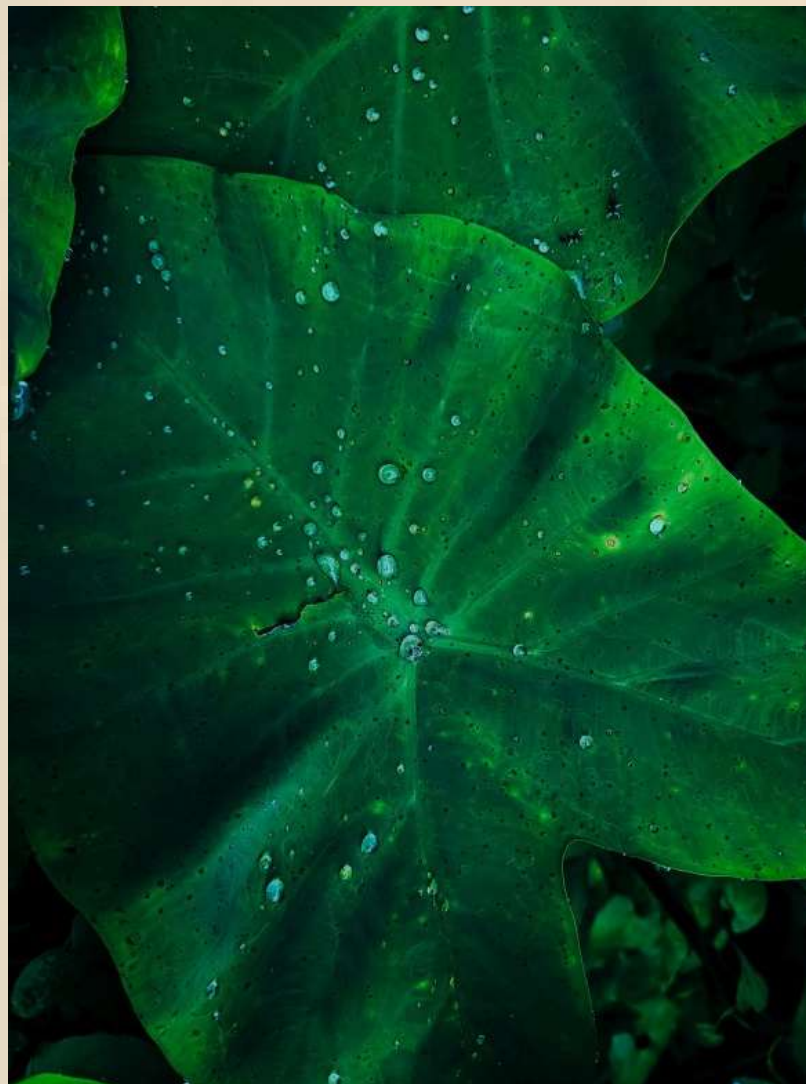
By Rohit Das, 3rd Year



**By Soumik Das,
4th Year**



**By Sourindra Haldar,
3rd year**



**By Rohit Das,
3rd Year**

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How IoT is Transforming Electrical Systems

- Aneesh Paul, 3rd Year

The Internet of Things (IoT) is transforming electrical systems around the world by placing sensors, communication networks, and analytics at all levels. This smart integration results in enhanced operation, optimized resource utilization, predictive maintenance, and reduced carbon footprint. As energy consumption and climate issues increase, IoT plays a crucial role in making electrical infrastructures efficient and sustainable.

Electrical engineering is evolving rapidly with the influence of IoT. No matter if we're talking about simple circuits or big power systems, IoT is bringing smarter solutions and ones with responsiveness. Not getting too technical here, but IoT really is making cool stuff happen. Things that run their own show and adapt intelligently have become more common and are opening all kinds of exciting possibilities.

1. Smart Grid Architecture & IoT Layers:

Smart grids of today are characterized by multi-layer IoT

structures comprising physical meters and sensors, network communication layers, cyber/data layers, and application-specific intelligence layers. Applications are advanced metering



Why did the bulb get promoted?

A: It was outstanding in its field.

infrastructure (AMI), transformer monitoring of health, real-time demand response, and DER (distributed energy resource) management.

2. Real-Time Monitoring & Energy Efficiency:

IoT sensors installed in substations, distribution transformers, and end-user meters supply data continuously to centralized analytics systems. Real-time anomaly detection prevents faults and blackouts through predictive maintenance approaches. In industry and building management, IoT energy management can reduce electricity consumption by 15–20%, and operating expenses by 10–15%.

3. Smart Meters & Demand Response:

Smart meters are the most prevalent IoT use in power systems. Research indicates that residential electricity charges can fall by 12%, and big commercial customers can save up to 58%. Furthermore, IoT-based demand response programs help utilities flatten peaks, lessening grid load and saving consumers money

4. Integration of Renewables & Energy Storage:



Why was the power line single?

A: Too many connections.

IoT platforms control distributed energy resources such as solar and battery storage. They control generation levels, grid frequency, and storage levels, enabling seamless integration of

renewables and enhancing energy reliability.

5. AI & Predictive Analytics:

Machine learning software processes data gathered from IoT for predicting equipment breakdowns, transformer loading optimisation, and dynamic supply-demand balancing. For example, Enel employs IoT sensors and artificial intelligence to identify thermal stress in transformers prior to failure. Google's AI-IoT combo reduced data centre cooling energy by 40%.

6. Sustainability & Future Impact:

IoT is a cornerstone for sustainable energy management. Predictions suggest global IoT energy systems may save over 1.6 petawatt-hours by 2030—enough power for 150 million homes annually. Smart buildings achieve energy reductions of 20–30%, with 30% lower maintenance costs. Smart meters in EU saved up to 9% emissions, reducing household energy use similarly. Additionally, IoT-enabled industrial infrastructures created 18% energy savings, 22% less downtime, and 15% improved resource utilization for manufacturing

environments. M2M-based systems were estimated to reduce global annual greenhouse gas emissions by 9.1 gigatons.

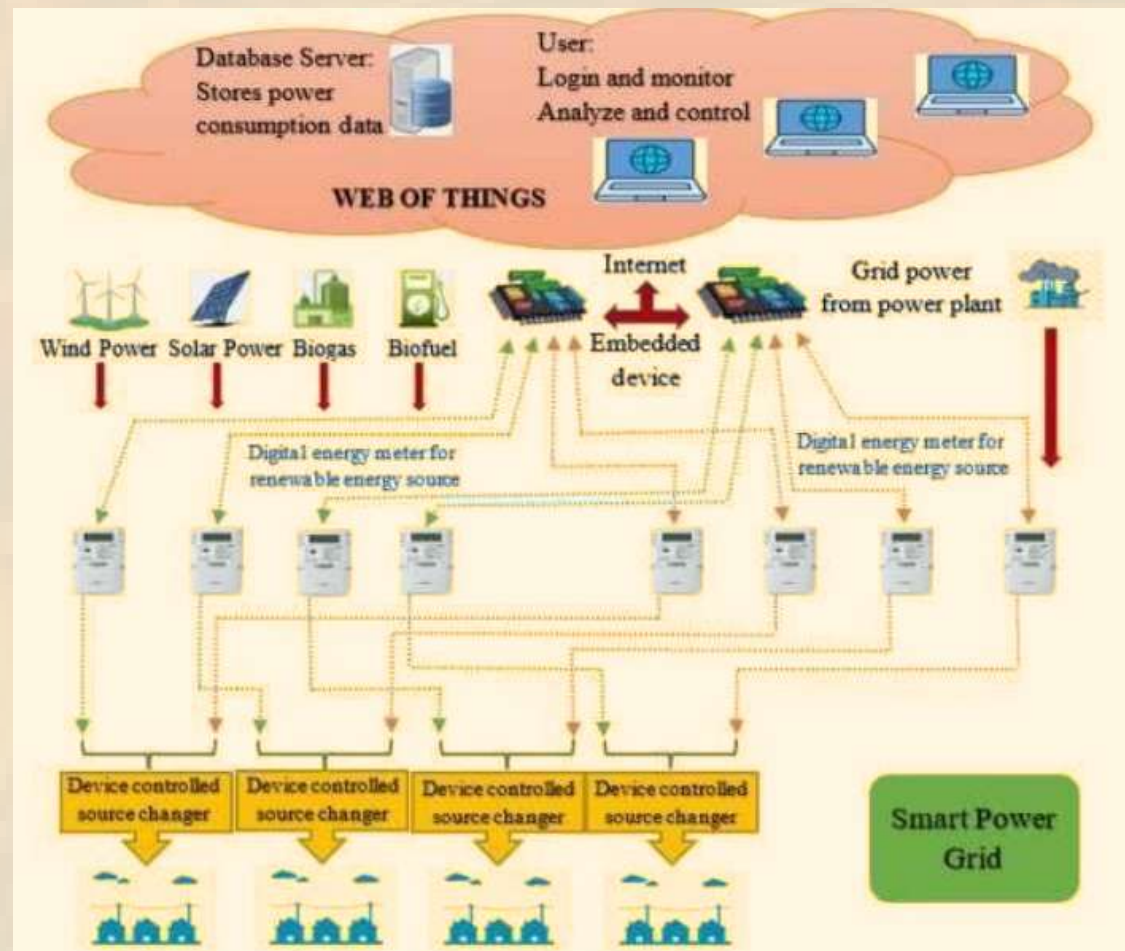


Why didn't the
transformer get my
joke?

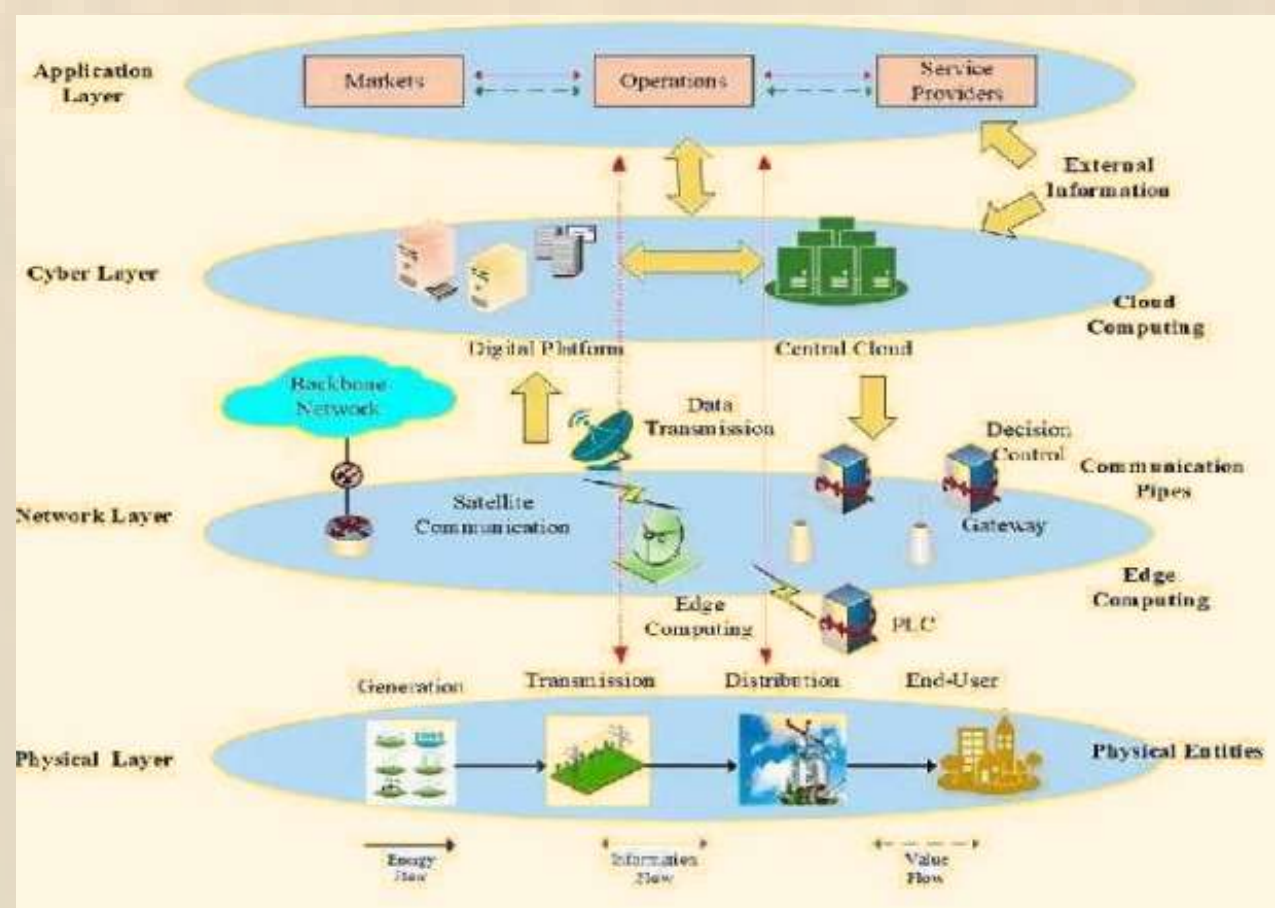
A: It didn't get the
voltage.

The images shown depict:

IoT architecture layers in smart grids:



Connectivity of the four-layer model from sensors to applications:

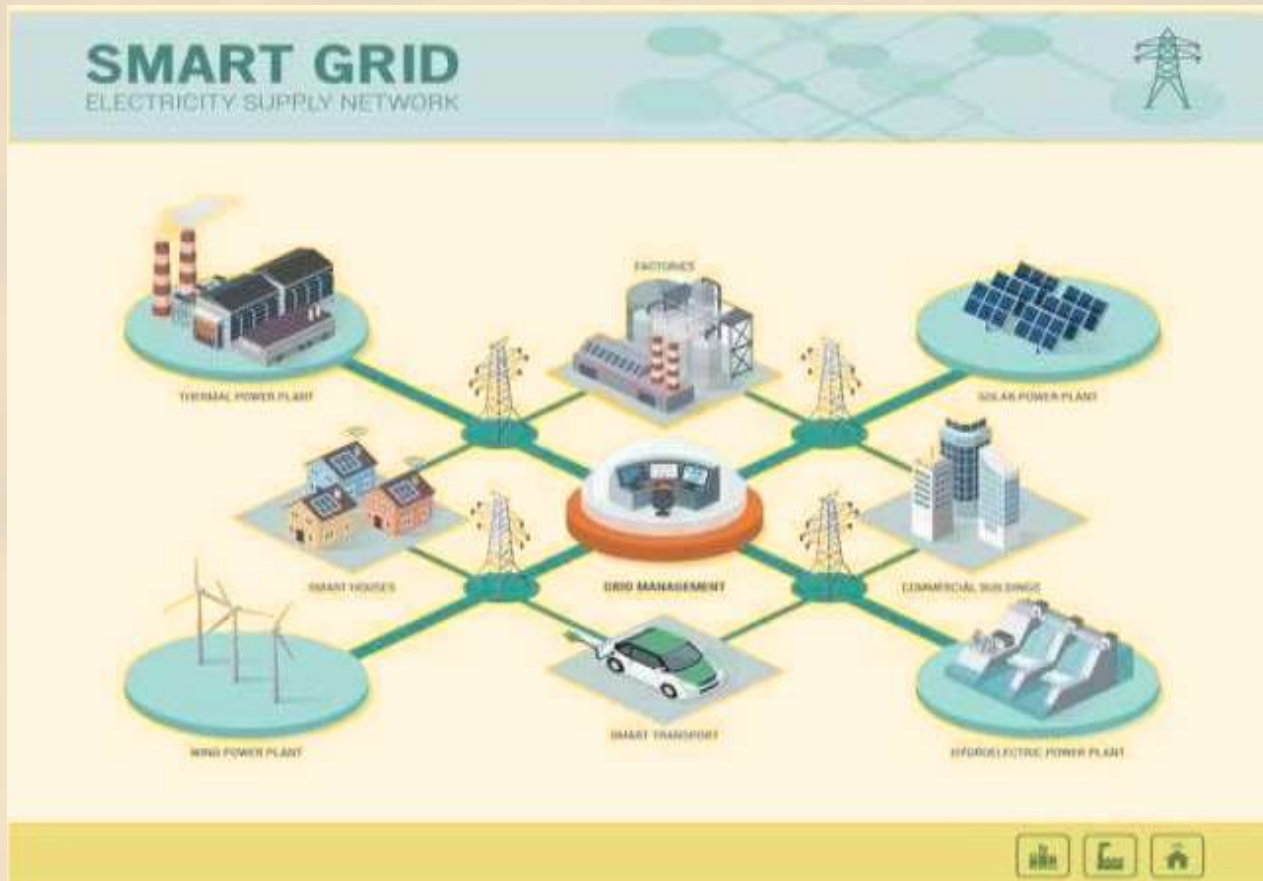


Why did the motor get stressed?

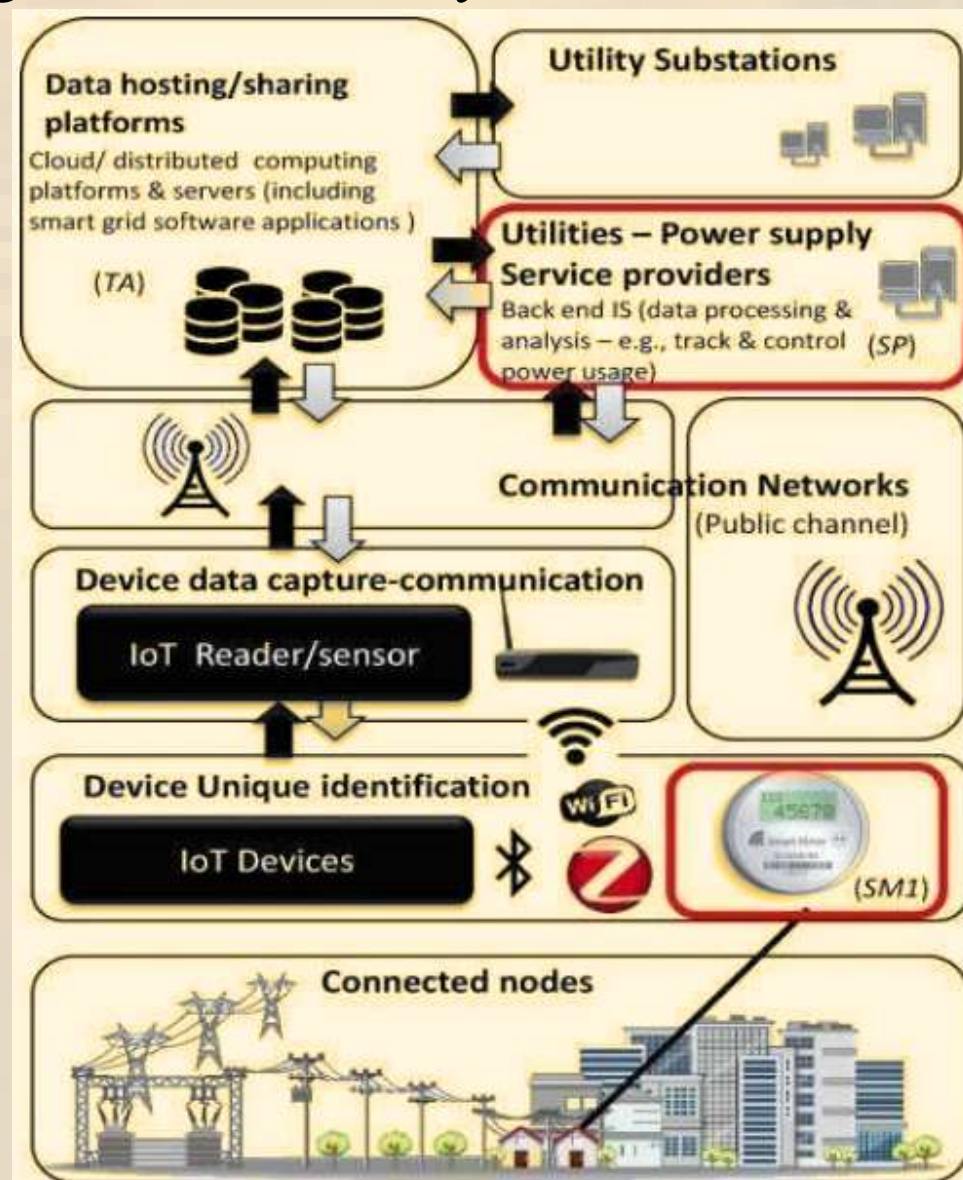
A: It was wound up.

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Smart grid connectivity throughout generation, distribution, and consumption:



IoT ecosystem linking DERs and analytics:



Why are electricians so calm?

A: They know how to conduct themselves.

Challenges and Considerations:

While the potential of IoT is immense, it's not without its challenges. As systems become more interconnected, the risks also increase. Security is a major concern. Every connected device is a potential entry point for cyberattacks. Ensuring robust encryption, secure communication channels, and regular updates is crucial. Managing system complexity is another issue. IoT ecosystems can involve hundreds or thousands of devices, each with its own software and hardware configurations. Engineers must ensure seamless integration and consistent performance.

Conclusion:

The Internet of Things (IoT) is way bigger than a funny bright flash in the tech sky. It's changing the very fundamentals that underpin electrical and electronics engineering, which is like planting a deep and strong root for this whole tech tree. The main motive is to build a sustainable electrified future. IoT's influence on electrical systems is both real-time and ongoing. By combining connectivity, data analytics, and automation, IoT



What happened when I told a resistor a joke?

A: It couldn't resist laughing.

makes grids more efficient, reliable, and resilient—while dramatically lowering carbon footprints.

To achieve IoT's full transformative impact, utilities and industries will need to overcome obstacles such as device interoperability, cybersecurity, and initial deployment costs. But success stories from IBM, GE, Barcelona smart lighting pilots, and manufacturing leaders speak to obvious ROI and sustainability value. Forward-looking, worldwide IoT deployment—as complemented by AI and edge/cloud computing—can assist in propelling the movement toward decarbonized, decentralized, and democratized energy systems.



The fan and the bulb argued.
The fan said, “I’m cooler!”
The bulb said, “I’m brighter!”
The switch turned them both off
and said,
“Now who’s important?”

Vocational Training on Traction Distribution (TRD) –
Sealdah Division, Eastern Railway.
- Sudip Mondal, 3rd Year

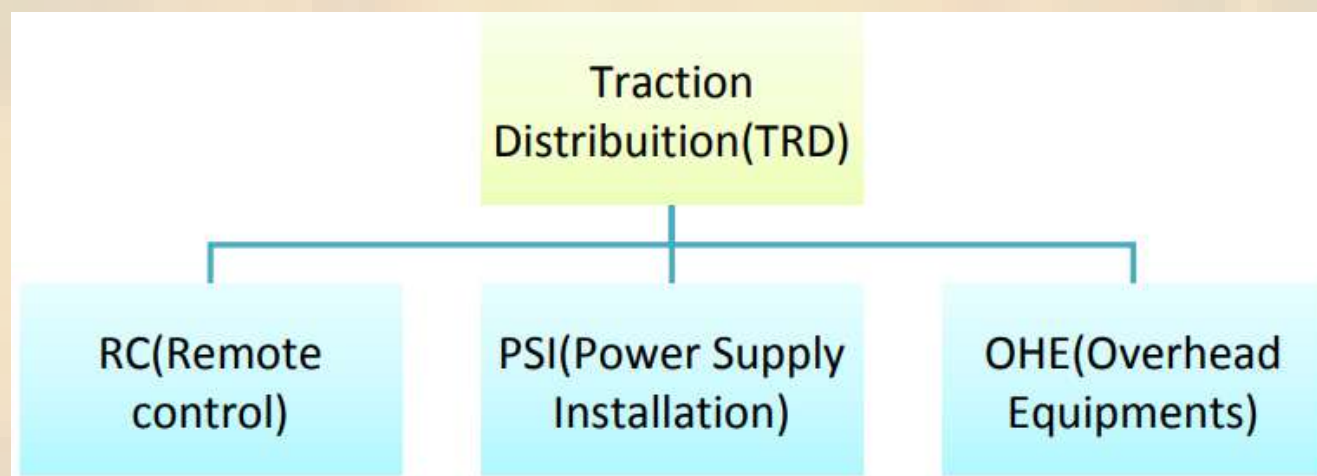
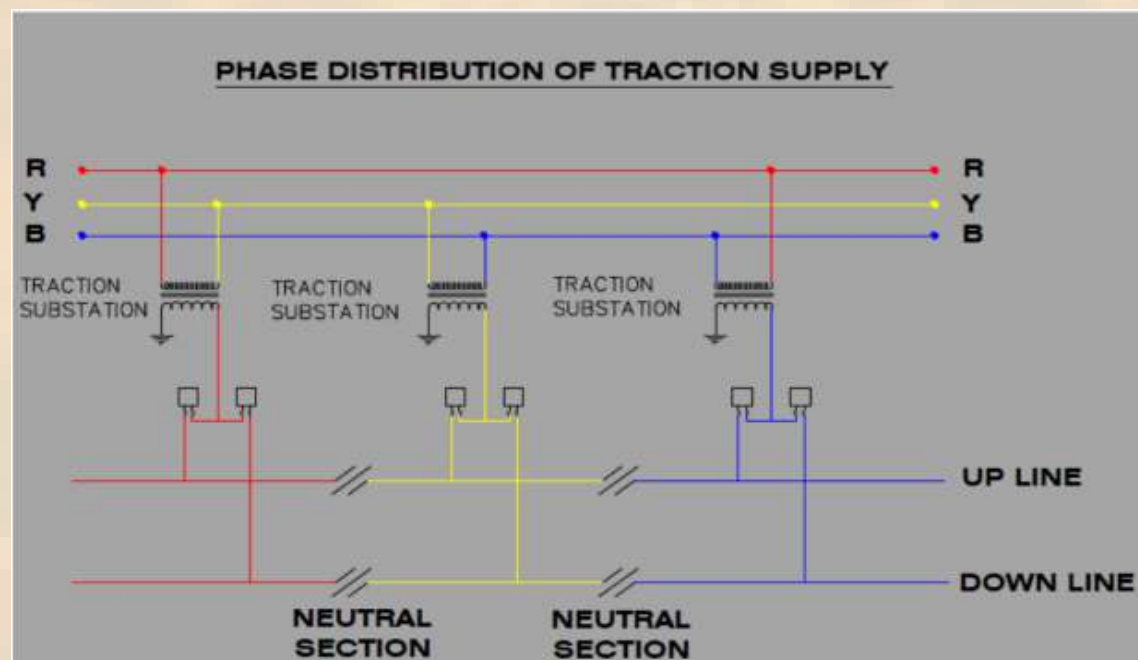
Introduction:

Traction Distribution (TRD) is a vital part of Indian Railways' electrified network. It is responsible for the transmission, control, and monitoring of electrical energy used to power trains. Operating at 25 kV AC, 50 Hz, the traction system supplies electricity through Overhead Equipment (OHE), fed by substations connected to the national grid. The TRD infrastructure ensures reliable and efficient train movement by integrating Remote Control (RC), Power Supply Installation (PSI), and OHE systems.

As part of our academic training at Heritage Institute of Technology, Kolkata, we underwent a three-week hands-on vocational program from June 27 to July 15, 2025, at the Sealdah Division of Eastern Railway. This training provided practical exposure to how Indian Railways manages and maintains its electrified network.



What did the resistor
say to the voltage?
A: Stop pushing me!



1. Remote Control (RC) and SCADA Systems:

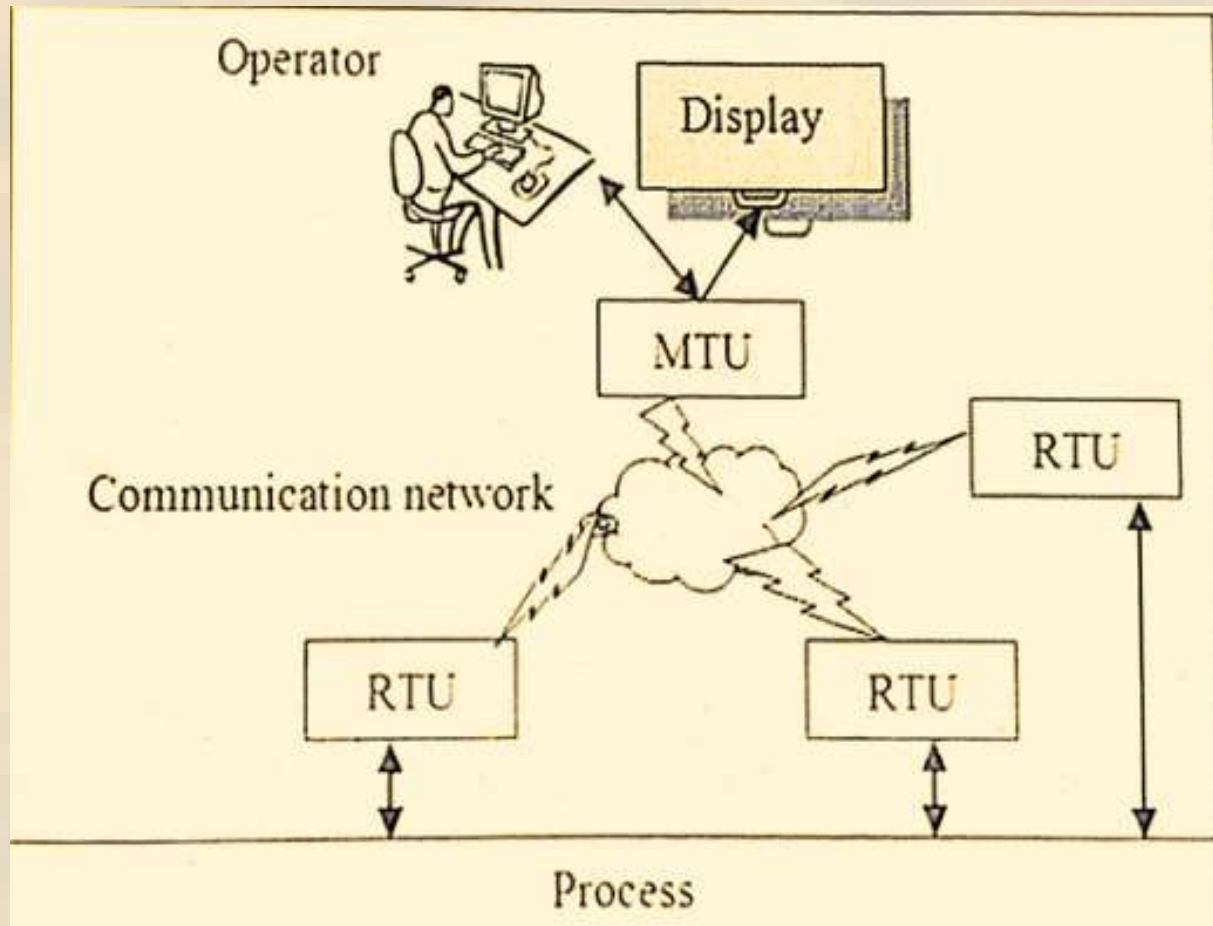
Remote Control (RC) plays a critical role in centralizing the monitoring and operation of traction power systems. We were introduced to SCADA (Supervisory Control and Data Acquisition), an advanced automation system used for remote monitoring, data collection, and control of field devices in real time. SCADA enhances reliability and efficiency through components such as:



Why shouldn't you trust an atom?
A: They make up everything, even circuits.

- HMI (Human Machine Interface): Displays real-time process data.
- RTUs (Remote Terminal Units): Collect data from sensors and transmit it.

- PLCs (Programmable Logic Controllers): Automate field device operations.
- Communication Infrastructure: Ensures connectivity across all control levels.



Through SCADA, we observed how power faults like line leakage or breaker trips are detected, analyzed, and relayed to control rooms, allowing immediate action without manual inspection.

2. Power Supply Installation (PSI):

PSI is responsible for ensuring uninterrupted power to electric

trains. The 25 kV AC, 50 Hz power is sourced from the State Electricity Board and stepped down at Traction Substations (TSS) located 35–50 km apart. Key components include:

Why did the light bulb fail class?

A: It didn't have a bright idea.

- Traction Transformers: Reduce incoming voltage to usable levels.
- Circuit Breakers & Relays: Control and protect supply systems.
- Lightning Arresters & Isolators: Protect against surges and allow safe isolation.
- Voltage Regulation: Maintains permissible voltage between 23.75 to 27.5 kV.
- Capacitor Banks: Improve power factor and electrical efficiency.
- Sectioning, Paralleling, and Feeding Posts: Distribute and isolate power to maintain supply continuity and safety.



We also explored relay panels, which house monitoring and protection devices critical for maintaining electrical safety during overloads and faults.

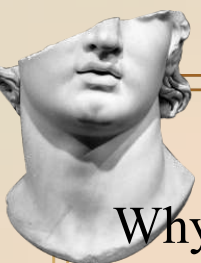
Why did the capacitor kiss the diode?

A: It couldn't resist.

3. Overhead Equipment (OHE):

OHE is the physical infrastructure that supplies power to moving trains through overhead conductors. Key components we studied include:

- **Contact Wire & Catenary Wire:** Made of copper, maintain tension and ensure smooth current collection.
- **Droppers:** Maintain a consistent height for the contact wire.
- **Auto Tensioning Devices (ATD):** Compensate for wire expansion due to temperature.
- **Masts & Cantilever Assemblies:** Provide structural support to the system.
- **Section Insulators, Bonds, and Jumpers:** Electrically segment the system and ensure load continuity.
- **Earthing Systems:** Protect infrastructure and personnel from electrical hazards.
- **OHE Inspection Car:** Detects damage, wear, or foreign objects like ropes or bird nests.



Why did the motor get stressed?

A: It was wound up.



We also studied bonding techniques (structure bond, rail bond, cross bond) and the layout of sub-stations like TSS, SP, SSP, and feeding posts that ensure safe and efficient operation of the railway network.

Conclusion:

The vocational training program at Sealdah TRD provided a comprehensive overview of railway electrification systems. From advanced SCADA control systems to high-voltage substations and complex OHE structures, each module deepened our understanding of power distribution and



Why do batteries never gossip?

A: They don't like being drained.

control in the Indian Railways. The hands-on exposure, guided by experienced engineers, has not only enhanced our technical skills but also motivated us to pursue further

knowledge in railway and power system engineering.

We are grateful to the dedicated staff and engineers at Sealdah Division for their support, patience, and the knowledge they shared with us. This experience will remain a cornerstone in our academic and professional journey.



Why did the capacitor break up
with the battery?

Because it found the battery too
short-lived.

It said, “I need someone
Who can hold a charge longer!”

Understanding Transmission Lines, The Backbone of Electrical Power Systems

- Uday Ray Barman, 3rd Year

Transmission lines are an essential part of modern electrical power systems. They carry high-voltage electricity from generating stations to substations and, eventually, to consumers through distribution networks. Without efficient transmission lines, reliable power delivery over long distances would be impossible. As energy demands grow, understanding the structure, types, and functioning of transmission lines becomes increasingly important for students and engineers alike.

Transmission lines are long conductors used to transport electric power over long distances at high voltages. The main purpose is to reduce power loss and increase efficiency by transmitting at high voltage and low current.

A standard transmission line includes the following main components:

i) Conductors: Usually made of aluminium or ACSR (Aluminium Conductor Steel Reinforced), as they are lightweight and conductive.

ii) Towers or Poles: Support structures that keep the conductors elevated and spaced.



Why can't I put down my book on electricity?

A: Because it's charged!

- iii) Insulators: Prevent current from flowing to the towers; made from porcelain or polymer.
- iv) Ground wires: Protect the line from lightning by safely conducting surge voltages to the ground.
- v) Substations: At either end of the line to step up or step-down voltages using transformers.

Transmission lines are broadly classified based on voltage levels and structure, but sometimes they may also on the basis of line length:

i) Based on Voltage:

- High Voltage Transmission Lines (33kV to 220kV)
- Extra High Voltage Lines (220kV to 765kV)
- Ultra-High Voltage Lines (above 765kV)

ii) Based on Physical Structure:

- Overhead Transmission Lines: Most common, cheaper to install, but exposed to weather.
- Underground Transmission Lines: Safer and visually unobtrusive, but more expensive and harder to maintain.



Why did the electron go to school?
A: It wanted to be positive.

iii) Based on Line Length:

- Short Transmission Lines: Less than 80 km, where resistance and inductance are considered.
- Medium Transmission Lines: 80–250 km, where capacitance is included in calculations.
- Long Transmission Lines: More than 250 km, requiring complex analysis using distributed parameters.

Some electrical parameters of transmission lines are:

- Resistance (R): Causes power loss in the form of heat.
- Inductance (L): Due to magnetic fields created around conductors; affects voltage regulation.
- Capacitance (C): Caused by potential difference between conductors and ground; increases with line length.
- Conductance (G): Leakage current through insulators or air; usually very small.

These parameters affect voltage drop, line losses, and power handling capability. Power loss mainly occurs due to resistance (I^2R loss) and the efficiency of any system is improved by increasing transmission voltage, which reduces current and, hence, resistive losses.



What happened when two wires fell in love?

A: The wedding was shocking.

Corona Loss:

A special type of loss caused by ionization of air around conductors at high voltage, producing a hissing noise and light. To transmit large amounts of power over long distances efficiently, voltage is increased so that current can be reduced. Lower current reduces heat loss and improves efficiency

Proper insulation, regular maintenance, and protection systems (like circuit breakers and relays) are critical for safe operation. Live-line maintenance and drone-based inspections are modern techniques used today. Transmission lines play a fundamental role in delivering electricity from power plants to end users across cities, towns, and even remote areas. Their efficiency, safety, and reliability directly affect the performance of the entire power system. For students and professionals in electrical engineering, a clear understanding of transmission line components, parameters, and types is essential. As technology advances, smarter grids and better materials continue to improve transmission efficiency, ensuring that energy reaches every corner of the modern world without interruption.



Why was the switch nervous?

A: It had a lot of current events.

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VELLUM

IDENTITY



RURAL REPORT**- Soumyadip Baidya, 2nd Year**

Hingalganj on the Brink: A Land of Peril and Promise

District: North 24 Parganas, West Bengal

Report Date: July 19, 2025

1. Executive Summary:

Hingalganj, a Community Development Block at the fragile easternmost edge of India, is a microcosm of the global climate crisis. Situated on the international border with Bangladesh within the Sundarbans delta, its 230.4 sq. km landscape is a battleground between human resilience and relentless nature. The lives of its inhabitants are dictated by the rhythm of the tides and the increasing ferocity of the climate. While the Census of 2011 provides a crucial demographic baseline—a population of 174,545 with over 73% belonging to Scheduled Castes and Tribes—the story of the last decade has been one of accelerated change. A relentless series of cyclones, culminating in Amphan (2020) and Yaas (2021), has intensified the chronic issues of land erosion, water salinization, and livelihood precarity.

The economy remains tethered to climate-vulnerable sectors: single-crop agriculture threatened by salt, high-risk fishing, and a booming but ecologically costly aquaculture industry. This has fueled large-scale male out-migration, creating a "money-order" economy that strains the social fabric. This report integrates the latest available data and analyses post-2020 ground realities to present a holistic picture of Hingalganj. It examines its environmental stressors, socio-economic fabric, infrastructural challenges, and the urgent, innovative adaptations being forged by its people in their fight for a viable future on a sinking frontier.

2. The Unforgiving Environment: A Land in Flux:

The geography of Hingalganj is its destiny. A flat, low-lying deltaic plain, its existence is maintained by a network of fragile earthen embankments that hold back the tidal rivers like the Ichamati, Raimangal, and Kalindi. The average elevation of just 3-4 meters above sea level makes it perpetually vulnerable.

Climate Change: From Threat to Daily Reality

The abstract threat of climate change is a lived reality here. The most devastating manifestation is the increasing frequency and intensity of cyclones. While Aila (2009) was a benchmark disaster, the twin strikes of Super Cyclone Amphan (2020) and Cyclone Yaas (2021) created a "compound disaster" scenario. Amphan's winds

shattered infrastructure, and before communities could fully recover, Yaas brought massive storm surges, breaching embankments and causing mass saline flooding. Reports from the West Bengal State Disaster Management Authority documented tens of thousands of homes damaged and vast tracts of agricultural land inundated in the block.

This saline ingress is the region's slow-moving poison. Recent studies by local universities and environmental NGOs have shown a consistent rise in soil and water salinity levels, with some river systems in the region seeing salinity rise by over 20% in the last decade. This contamination renders land infertile for years, poisons freshwater ponds used for drinking and bathing, and fundamentally alters the ecosystem.

3. Demographics: A Community in Transition:

The 2011 Census remains the last official comprehensive dataset. It paints a picture of a densely populated rural area with a significant gender gap in literacy (84.24% for males vs. 69.17% for females) and a population heavily composed of socially marginalized groups.

While official population updates are unavailable, the decade since has been defined by one overwhelming demographic trend: out-migration.

Economic distress and the lack of local, yearround employment have institutionalized the practice of male members migrating for work. They travel to Kolkata, Kerala, Maharashtra, or Gujarat, working in construction or factories. This has profoundly altered the social structure, creating villages populated primarily by women, children, and the elderly. While the remittances sent home are a crucial economic lifeline, this "money-order economy" comes at a high social cost, including increased workload and responsibility for women, challenges in child-rearing, and a fraying of traditional community support systems.

4. Economy and Livelihoods: A Portfolio of Risk:

The economy of Hingalganj is a high-risk portfolio dependent entirely on natural resources. The workforce, as per the 2011 Census, was characterized by a high number of agricultural labourers (17,577) compared to land-owning cultivators (7,767), and a staggering 45.4% were 'Marginal Workers,' employed for less than six months a year. Recent trends have only deepened this precarity.

Agriculture: A Losing Battle with Salt:



Why do batteries love school?

A: They learn in series and parallel.

Traditional agriculture is a gamble. The monsoon-fed Aman paddy is the only major crop, but its success is not guaranteed. A single breach of an embankment during a cyclone or high

tide can ruin a year's harvest. In the wake of Yaas, thousands of hectares remained fallow due to extreme salinity. While salt-tolerant rice varieties are being promoted, their yield is often lower, and they represent an adaptation to a worsening situation rather than a solution.

Aquaculture: The 'Pink Gold' Rush:

The decline of agriculture has fueled a boom in brackish water aquaculture, particularly shrimp and prawn farming. These aquaculture ponds, or bheris, have become the dominant feature of the landscape. Shrimp is the region's "pink gold," a high-value cash crop for the export market. However, this economic shift has severe ecological and social consequences. It often involves illegally clearing mangrove buffer zones, increasing the land's vulnerability. Furthermore, the saline water required for shrimp farming often seeps into and contaminates adjacent agricultural plots and freshwater sources, creating conflict within communities. The industry is also controlled by a few large operators, with most local people working as low-wage labourers.

Fishing and Forest Resources:



Why did the motor
join the gym?

A: To get more
torque.

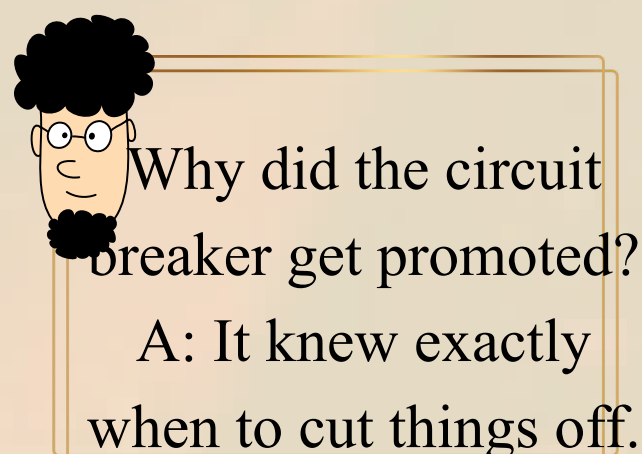
For the poorest households, the rivers and forests are the last resort. Fishermen face immense dangers, from pirates and territorial disputes near the international border to attacks by tigers and

crocodiles. Similarly, traditional honey collectors (Moulis) and crab catchers venture into the dense mangrove forests, where the risk to life is constant for a meager, unpredictable income.

5. Infrastructure and Services: A Constant State of Repair:

- **Government and NGOs:** Various government schemes like MGNREGA (providing employment, especially in embankment repair), PMAY (housing), and disaster relief programs are active. Numerous NGOs are working on promoting climate-resilient agriculture (e.g., promoting salttolerant seeds), mangrove afforestation, women's empowerment through Self-Help Groups (SHGs), and providing healthcare services.
- **Climate-Resilient Agriculture:** There is significant potential in promoting integrated farming systems, such as paddy-cum-fish cultivation and cultivating alternative, salt-tolerant crops.
- **Ecotourism:** The unique landscape offers immense potential for community-based ecotourism. Well-managed homestays and guided tours can provide an alternative source of income that incentivizes conservation.

- **Value Addition:** Instead of selling raw produce, small-scale processing units for fish, crab, and honey could increase local incomes.



6. Conclusion:

Hingalganj is a land of immense resilience, where life is a continuous negotiation with nature. The people have developed traditional coping mechanisms over generations, but the unprecedented pace of climate change is overwhelming these systems. The future of Hingalganj hinges on a twopronged approach: firstly, urgent and robust climate adaptation measures, including strengthening embankments and mainstreaming saline-resistant technologies. Secondly, a concerted effort to create diversified, sustainable, and non-farm livelihoods, particularly through skill development and the promotion of ecotourism. Without such interventions, this fragile and vital part of the Sundarbans delta faces a deeply uncertain future.



বন্ধবিনা

-শুভম ঘোষ, 2nd Year

বন্ধু, তোদের বড্ড মনে পরে
হটাৎ ভীষণ মনটা কেমন করে।
সবারই যোগ আছে সবার সাথে
নেই হাঁটা পথ হাতটা রেখে হাতে।
পথগুলো সব অন্যরকম আজ
ব্যস্ত সবাই, সবার আছে কাজ।
কাজের মাঝে, ভিড়ের ফাঁকে একা
মনের মধ্যে হটাৎ-ই দিস দেখা।
নতুন সবই শুরু হয়েছে জানি
বন্ধু তবু তোদের শুধু মানি।
এখন সব আপন আপন পর
ভালোই ছিল আমাদের ঘর।
সবাই মিলে গল্প, আড্ডা, মজা
স্কুলের টিফিন ভাগ করে খেয়ে, খেলা, ঝগড়া আর স্যার দেব কাছে সাজা।
একসাথে সেই পড়তে যাওয়া আসা
জায়গা রেখে খুনসুঁটি করার জন্য তোদের পাশে বসা।
অতীত এখন সে সব স্কুল টিউশনির দিন



ইউনিফর্মের জীবনখানা এখন বড্ড রঙিন।
ক্লাসের গল্প স্কুলেই হয়েছে শেষ
যদিও জীবনে রয়ে গেছে তার চিরকালীন রেশ।
সবাই এখনও যদিও একইসঙ্গে নাই বা থাকি
অনেক গল্প রইলো আজও বাকি।
হাতের সময় শেষ হয়েছে আজকের মত উঠি
শেষ হয়েও হলো বন্ধু বিনার খুনসুটি।।



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EE



LEGACY

Success at CAT-2022 (only 90 percentile and above quoted)

Sl. No.	College Roll No.	Student's Name	CAT-2022 Score (only 90 percentile and above quoted)
1.	1959057	Pranav Kumar Singh	98.40
2.	1959025	Subhankar Chakraborty	97.17
3.	1759017	Anindita Dutta	97.28

Academic Year: 2021-22

Name	Name of the Competitive Examination	Rank/Percentile/Score
Tathagata Roy	GATE	136
Arnish Bhattacharya	GATE	712

Academic Year: 2020-21

Name	Name of the Competitive Examination	Rank/Percentile/Score
SAYANTAN MITRA	ILETS	8(Score)
SOURADEEP GHOSH	TOEFL	103/120
MITHLESH KUMAR	GATE	775
ANIRUDHYA JHA	CAT	97.23 Percentile
SARTHAK SINGHA	CAT	93.82 Percentile

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TERRA

INCOGNITA



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SPORT'S WEEK

110

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Thank You