



Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
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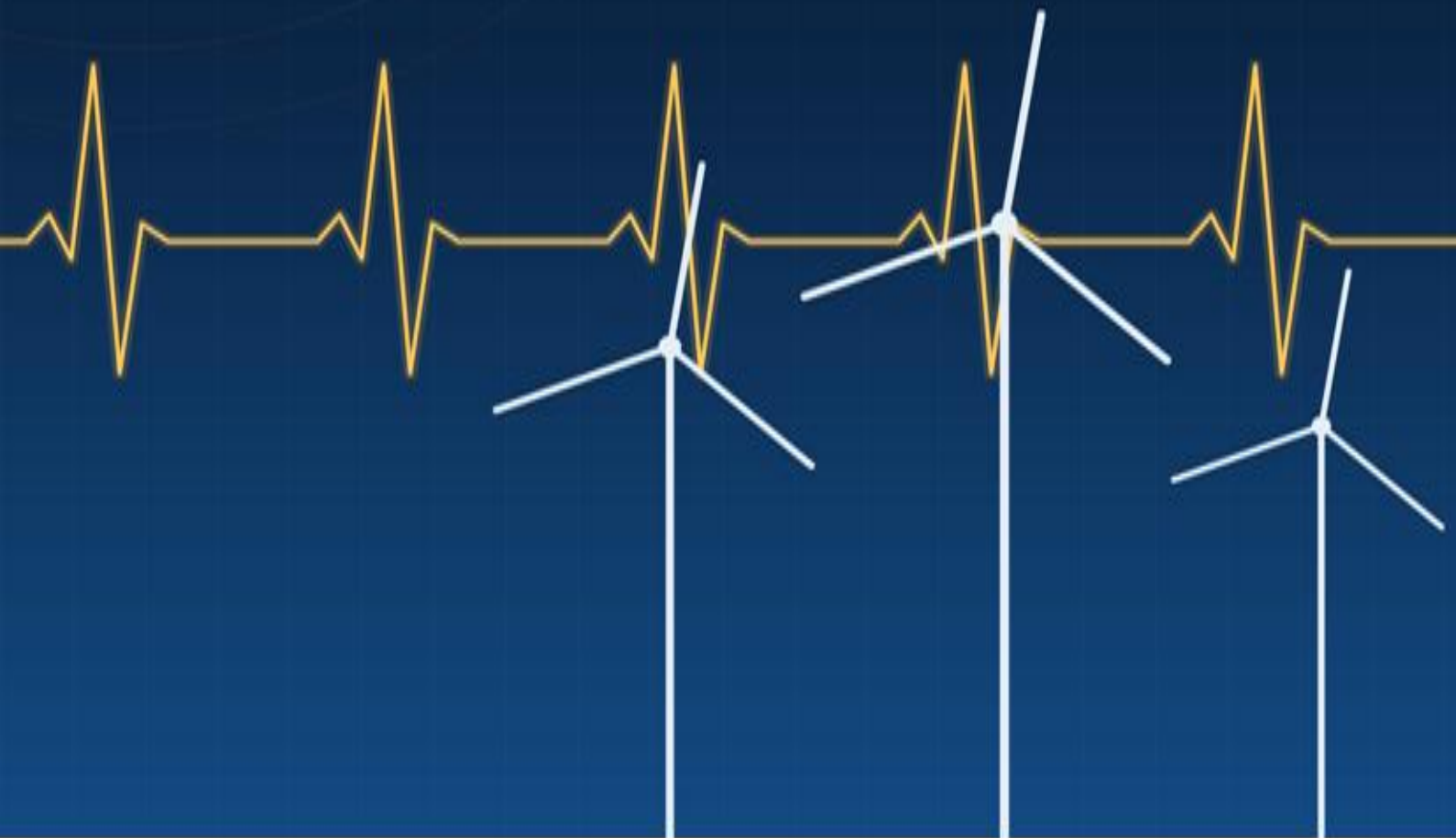
SCHOOL OF ELECTRICAL AND COMMUNICATION

**DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING**

Spark Magazine

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Foreword



Col. Prof. Vel. Dr. R. Rangarajan
Founder President & Chancellor



Dr. Mrs. Sagunthala Rangarajan
Foundress President

We remain committed to building an educational environment that nurtures knowledge, character, innovation, and excellence. Our institution continues to encourage students and faculty to pursue meaningful academic, research, and technological endeavors, supported by modern infrastructure, well-equipped laboratories, and a dedicated faculty. The Department of Electrical and Electronics Engineering reflects this vision through its academic achievements, research initiatives, funded projects, industry collaborations, and the accomplishments of its students and faculty.

Foreword



Mrs. Rangarajan Mahalakshmi Kishore
Chairperson & Managing Trustee

Delighted to witness the achievements of faculty and students across academic and research activities, the Chairperson congratulates the entire team on the effort behind this report and commends the department for producing talent-driven, innovative engineers to meet society's new and challenging issues.



Foreword



Prof. Dr. Rajat Gupta
Vice Chancellor

I am delighted to present the latest edition of Spark, the flagship magazine of the EEE Department. This magazine reflects our continuous pursuit of research excellence, creativity, co-curricular activity and technical learning of our students. Kudos to the editorial team, faculty, and brilliant students whose hard work and contributions made this edition possible.



Prof. Dr. E. Kannan
Registrar

I warmly congratulate the EEE Department on launching this vibrant edition of Spark. This platform beautifully captures the dynamic activities, student achievements, and academic excellence of the department. I wish the EEE team continued success in inspiring our community through such creative and meaningful initiatives.



Message from Dean and Head of the Department

Dr. R. S. Valarmathi

Professor & Dean
School Of Electrical and Communication



The School continues to make remarkable progress, driven by the achievements of our faculty, students and staff in cutting-edge research, academic excellence, and industry collaboration. Spark, the magazine of EEE department serves as a wonderful window into this journey—reflecting our focus on innovation, hands-on learning, and community impact. I commend the entire team for shaping our students into future-ready professionals and bringing these milestones to light.

Dr. K. Karunanithi

Professor & Head
Department of Electrical and Electronics Engineering



It is with great pleasure and a deep sense of pride that to present the SPARK-Magazine of the Department of EEE. I encourage you to delve into the pages of this magazine to gain a deeper understanding of the remarkable work that has taken place within our department. Together, we can look forward to an even brighter future filled with groundbreaking research, transformative education, and meaningful contributions to the field of electrical and Electronics engineering.

VISION OF THE DEPARTMENT

To provide intellectual curiosity in the field of Electrical and Electronics engineering that produces skilled interdisciplinary engineers to serve the society.

MISSION OF THE DEPARTMENT

M1: To inculcate knowledge among the students through comprehensive curriculum.

M2: To enrich the academic experience in terms of flexibility, teamwork, design skills, practice and industrial trainings.

M3: To produce competent graduates suitable for a successful career in Industry and Research.

PROGRAMME EDUCATIONAL OBJECTIVE

PEO1: Design and analyse electrical and electronic systems by applying the knowledge of mathematics and engineering.

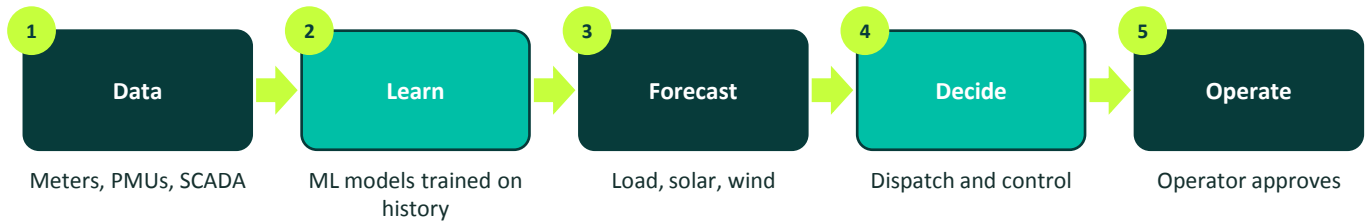
PEO2: Provide practical solution to multidisciplinary societal problems through innovative ideas.

PEO3: Secure positions and continue as valued, creative and proficient employees in a wide variety of fields and industries for a rewarding career.



AI in Smart Grids

How artificial intelligence is transforming power-system operation



A modern grid produces a flood of data from smart meters, sensors, protection relays and control centres. Artificial intelligence turns that data into decisions: forecasting demand and renewable output, flagging abnormal behaviour, scheduling flexible resources and giving operators faster look-ahead analysis. Machine-learning forecasts of load, solar and wind improve unit commitment and reserve planning, while reinforcement learning is being explored for voltage control and EV charging schedules. The challenges are just as real: data quality, explainability, cybersecurity and validation. In practice AI advises and the human operator stays in the loop.

KEY POINTS

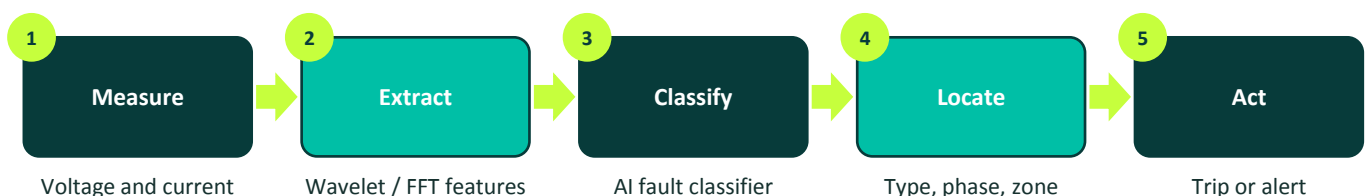
- Forecasting of load, solar and wind
- Anomaly detection in meters and equipment
- Optimised dispatch of flexible resources

CONCEPT · FORECASTING

Better forecasts mean smaller reserves and lower cost: the closer the prediction to reality, the less spare capacity the grid must keep waiting.

AI-Based Fault Detection and Protection

Smarter relays for grids full of inverters



Classical protection relies on high fault currents and simple thresholds. Inverter-based resources limit their fault current, so faults can look less severe and conventional settings may struggle to distinguish them from normal operation. AI-based schemes learn the signature of a fault from voltage and current waveforms. Features extracted with wavelet or Fourier transforms feed classifiers such as decision trees, support-vector machines or neural networks, which identify fault type, faulted phase and location within a few cycles. Because a wrong trip is costly, these tools are validated extensively and usually complement, not replace, proven relays.

KEY POINTS

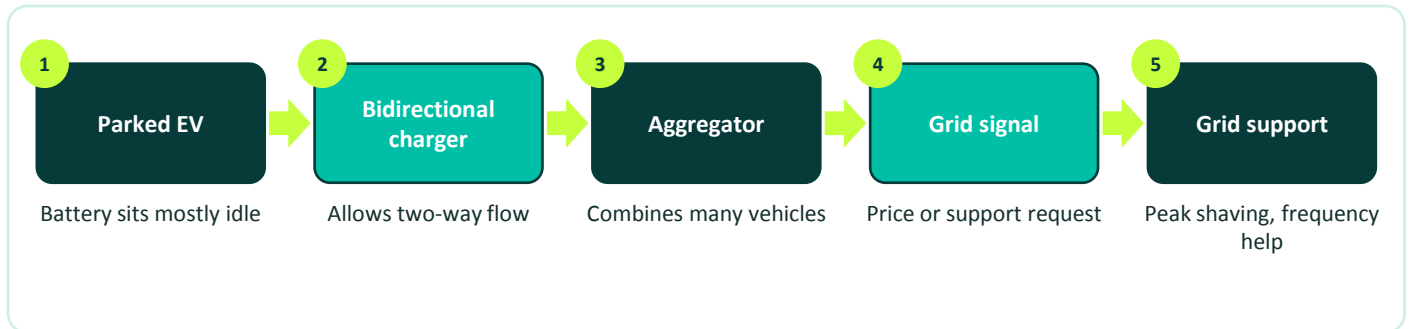
- Handles low, inverter-limited fault currents
- Classifies fault type, phase and location
- Must be secure as well as fast

CONCEPT · DEPENDABILITY VS SECURITY

A relay must trip when it should (dependability) and stay quiet when it should not (security). AI must be judged on both.

Vehicle-to-Grid (V2G)

How EVs can support the electrical grid



A parked electric vehicle is a battery on wheels, idle for most of the day. With vehicle-to-grid, the car can send energy back to the grid as well as draw it, turning millions of vehicles into a distributed storage resource. Charging can be shifted to the middle of the day when solar output is high, and discharge can be scheduled to help the evening peak or to provide frequency support. This needs a bidirectional charger, communication standards such as ISO 15118-20, and smart control by an aggregator. Battery wear and fair payment for the owner are key design questions.

KEY POINTS

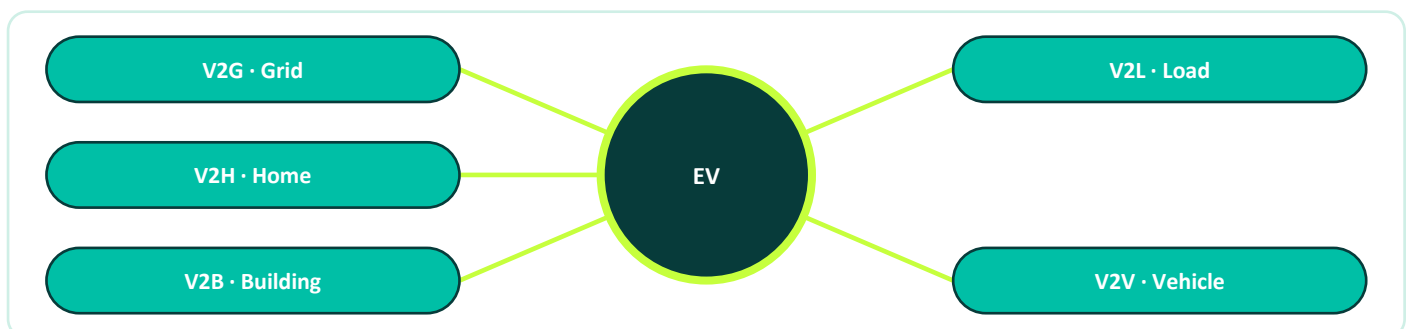
- Charge when energy is abundant
- Discharge when the grid needs support
- Needs bidirectional chargers and aggregation

CONCEPT · AGGREGATOR

One car is tiny for a grid operator. An aggregator combines many cars into one controllable resource.

Vehicle-to-Everything (V2X)

V2G, V2H, V2L and V2V technologies



V2X is the family of technologies that let an EV share energy with the world around it. Each member of the family answers a different need, from powering a house during an outage to helping another car that has run out of charge. V2G exports energy to the grid; V2H (vehicle-to-home) backs up or supplements a household; V2L (vehicle-to-load) runs appliances or tools directly from the car; V2V (vehicle-to-vehicle) transfers energy between two vehicles. V2B (vehicle-to-building) applies the same idea to commercial buildings. All rely on power electronics that can control the direction of power flow safely.

KEY POINTS

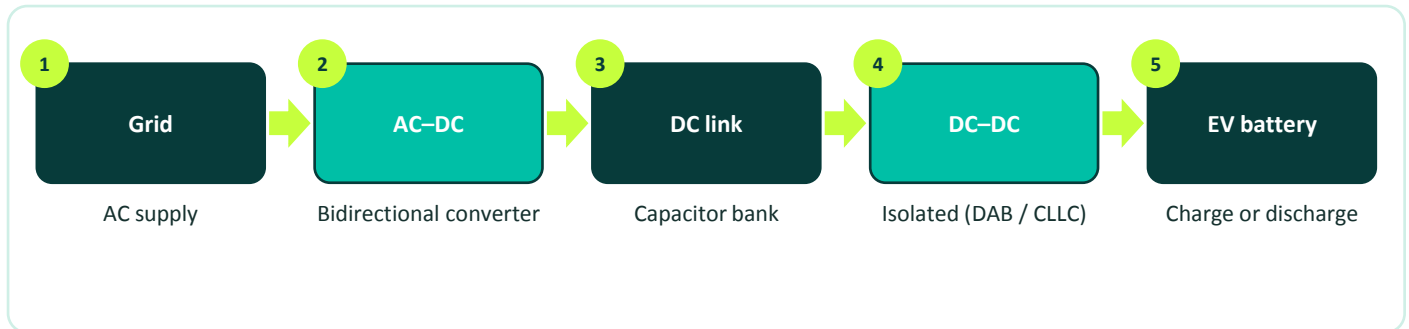
- V2G: export to the grid
- V2H / V2B: back up homes and buildings
- V2L and V2V: power loads and other vehicles

CONCEPT · V2L

V2L is the simplest form: a socket on the vehicle that supplies AC power, with no grid connection required.

Bidirectional EV Chargers

The future of smart EV charging



A conventional charger moves energy in one direction only. A bidirectional charger can also return energy from the battery to a home, building or the grid, and it is the key enabler for V2G, V2H and V2L. Most designs use two stages: a bidirectional AC-DC converter that shapes the grid current and regulates the DC link, followed by an isolated DC-DC converter such as a dual active bridge or a CLLC resonant converter. Wide-bandgap devices help raise efficiency and power density. Grid codes, anti-islanding protection and communication with the vehicle complete the design.

KEY POINTS

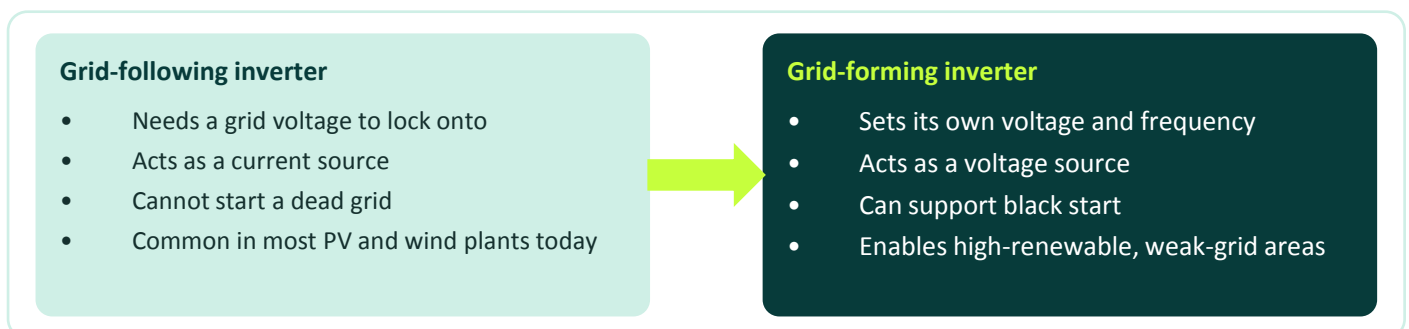
- Two conversion stages with an isolated DC-DC link
- Efficiency and power density from SiC/GaN
- Must meet grid codes and safety standards

CONCEPT · ON-BOARD VS OFF-BOARD

On-board chargers sit inside the vehicle and are power-limited. Off-board DC chargers sit in the station and can deliver much higher power.

Grid-Forming Inverters

Enabling stable operation of renewable-rich power systems



Most inverters today are grid-following: they measure the grid voltage with a phase-locked loop and inject current to match it. They need a strong grid to follow. As synchronous generators are replaced by inverters, that assumption weakens. A grid-forming inverter behaves like a voltage source that sets its own voltage and frequency reference, similar to a synchronous machine. Using droop control or virtual synchronous machine strategies, it can share load, provide synthetic inertia, support weak grids and help with black start. Its limit is a finite current rating, so its behaviour during faults must be carefully designed.

KEY POINTS

- Creates its own voltage and frequency reference
- Supports weak grids and black start
- Limited by inverter current capability

CONCEPT · FOLLOWING VS FORMING

Grid-following: a current source that needs a grid to follow. Grid-forming: a voltage source that helps build the grid.

Inverter-Based Renewable Energy Resources

Challenges in modern power grids



Solar, wind and battery systems connect to the grid through power electronics rather than large rotating machines. That brings flexibility and fast control, but it also changes how the grid behaves in the first seconds after a disturbance. Lower system inertia makes frequency change faster, and weak grids with low short-circuit strength can trigger control interactions and oscillations. Limited fault current complicates protection, and strict ride-through rules are needed so that plants stay connected during disturbances. Inertia is the stored rotational energy of generators; it slows frequency change and buys time for controls to respond. Solving these challenges needs better grid codes, better modeling and wider use of grid-forming technology.

The future perspective of inverter-based renewable energy resources is centered on transitioning power grids from a reliance on traditional rotating generators to complete inverter dominance. As the global energy landscape accelerates toward net-zero targets, inverter-based resources (IBRs) such as solar photovoltaics, wind turbines, and battery storage systems are expected to supply nearly 100% of regional power generation during peak periods. This paradigm shift requires advanced "smart" inverters equipped with grid-forming (GFM) control capabilities rather than conventional grid-following designs, enabling them to actively establish voltage and frequency references instead of just tracking them. Future power systems will leverage wide-scale integration of wide-bandgap semiconductor materials like silicon carbide to achieve unprecedented conversion efficiencies exceeding 99% alongside much higher power densities. Furthermore, these next-generation power electronics will seamlessly coordinate with vehicle-to-grid (V2G) networks, decentralized internet of things (IoT) infrastructure, and advanced energy storage systems to offer vital ancillary services like synthetic inertia and fault-ride-through. Ultimately, intelligent inverter technologies will evolve into autonomous, proactive managers of energy flow, ensuring that future grids remain resilient, flexible, and completely stable despite the intermittency of renewable sources.

VTU19765 Abhishek kumar

Voltage in the Wires

*A current runs where reason cannot always reach,
Through copper veins and silicon it learns to teach.
A grid once built on furnaces and turning steel,
Now listens to the sunlight and the way the breezes feel.
So here's to every inverter, every sensor, every line –
The quiet electric poetry of a system we call divine.*

Showers of Rain

*A Softly falling from the gray above,
A gentle whispering song of grace,
Cooling down the summer heat with love,
Washing clean the dust from nature's face.
The earth exhales a fragrance sweet and deep,
While dancing drops perform on every leaf,
Awakening the silent world from sleep,
And bringing thirsty lands a sweet relief.*

VTU19765 Abhishek kumar

ESSAY

The Invisible Backbone

Look around any room and count the things that need electricity to work: the light above you, the fan turning quietly, the phone charging on the table, the refrigerator humming in the next room. None of these devices care where their power came from, and most of us never think about it either. That is, in a strange way, the biggest achievement of a power system: it is designed to be invisible.

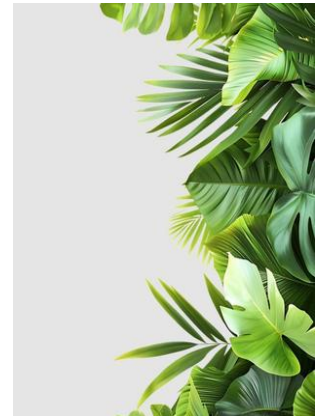
Behind that invisibility sits an enormous, coordinated effort: generators spinning in step across an entire country, relays ready to isolate a fault in a fraction of a second, control rooms balancing supply and demand every moment of the day. Engineers do not build power systems to be admired; they build them to be forgotten, trusted the way we trust gravity. The next time a switch simply works, it is worth remembering the invisible backbone that made it so ordinary.

NATURE

Neem: Nature's Green Pharmacy

The neem tree (*Azadirachta indica*) is a fast-growing evergreen native to the Indian subcontinent, easily recognised by its feathery, dark-green leaves and small white flowers. It thrives in hot, dry climates and is a familiar sight along roadsides, courtyards and temple grounds across India.

Nearly every part of the tree has a traditional use: the leaves in skin remedies and pest control, the twigs as a natural toothbrush, and the oil in soaps and lotions. Farmers value neem cake as an organic pesticide and soil conditioner, and its bitter reputation has made it a lasting symbol of natural medicine in Indian households.



POETRY CORNER

First Light on Copper

*Before the city stirs, the wires are already awake,
Carrying the quiet promise the morning sun will make.
A student dreams of circuits, a professor checks a page,
And somewhere a young engineer begins a lifelong stage.
So charge your mind with wonder and your heart with steady will –
The current of tomorrow starts with the students of Vel Tech.*

Rangoli: Dots, Dust, Delight



VTU21247 Tejaswini

Art: Shading Some Real Truth!



VTU20975 Thoji Kajiri

Brain Teaser

- What is the SI unit of electrical resistance?

Answer: Ohm

- Which electronic component stores electrical energy electrostatically?

Answer: Capacitor

- What static electrical device transfers energy between circuits via electromagnetic induction?

Answer: Transformer

- Which semiconductor device acts primarily as a one-way valve for current?

Answer: Diode

- What is the SI unit of electrical capacitance?

Answer: Farad

- Which rotating machine converts mechanical energy into electrical energy?

Answer: Generator

- What instrument is used to measure electrical current in a circuit?

Answer: Ammeter

- What is the term for unwanted electrical disturbances or signals in a system?

Answer: Noise

◆ CREDITS

Editorial Team & Acknowledgements**ACKNOWLEDGEMENTS**

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