SRI MANAKULA VINAYAGAR ENGINEERING COLLEGE

(AN AUTONOMOUS INSTITUTION)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ECHOES

MAGAZINE OF ECE

2022 - 2023

ABOUT OUR COLLEGE

Sri Manakula Vinayaga Educational Trust was founded to provide quality and affordable education to the weaker sections of society. The trust established Sri Manakula Vinayagar Engineering College (SMVEC) in 1999. SMVEC is an autonomous institution affiliated to Pondicherry University. It offers a variety of undergraduate, postgraduate, and research programs in Engineering, Arts and Science, Allied Health sciences, School of Agriculture, Centre of Legal Education, School of Physiotherapy and School of Pharmacy.

VISION:

To be globally recognized for excellence in quality education, innovation and research for the transformation of lives to serve the society.

MISSION:

M1: Quality Education: To provide a comprehensive academic system that amalgamates the cutting edge technologies with best practices.

M2: Research and Innovation: To foster value-based research and innovation in collaboration with industries and institutions globally for creating intellectuals with new avenues.

M3: Employability and Entrepreneurship: To inculcate the employability and entrepreneurial skills through value and skill based training.

M4: Ethical Values: To instill a deep sense of human values by blending societal righteousness with academic professionalism for the growth of society.

ABOUT OUR DEPARTMENT

The Electronics and Communication Engineering (ECE) Department, founded in 1999, is dedicated to achieving excellence in learning, teaching, and research. Initially sanctioned with a 180-person intake in 2012, and increased to 240 in 2013. In 2006, the department established a PG programme with an 18-person intake. The B.Tech programme is NBA-accredited till 2025, and the college obtained an "A" from NAAC and Autonomous status in 2019. Our modern laboratories support Electronics, Communication, VLSI, Embedded Technology, and IoT, demonstrating our commitment to offering high-quality education and encouraging intellectual and professional development.

VISION:

Encourage academic excellence and ethical professionalism in Electronics and Communication Engineering to satisfy global needs.

MISSION:

M1: Prepare students for global issues in ECE.
M2: Promote research and innovation excellence.
M3: Increase employability and entrepreneurial abilities.
M4: Teach human values and professional ethics.

EMPERICAL STUDY

AI-POWERED EMBEDDED SYSTEMS

AI-powered embedded systems represent a transformative convergence between artificial intelligence (AI) and embedded electronics, enabling low-power devices to perform intelligent tasks locally without the need for constant cloud connectivity. This shift has been made possible by advances in lightweight machine learning models and powerful yet energy-efficient microcontrollers such as ARM Cortex-M, ESP32, Raspberry Pi Pico, and AI-specific chips like Google Coral, NVIDIA Jetson Nano, and the STM32 series.

Traditionally, AI required large computational resources, but with the emergence of TinyML (Tiny Machine Learning), it is now possible to run inference tasks such as speech recognition, image classification, gesture detection, and anomaly prediction directly on microcontrollers with limited RAM and processing power. These systems are used in a wide range of real-time applications including smart home automation, industrial fault detection, agriculture (e.g., crop health monitoring), wearable fitness devices, and edge-based surveillance systems. For example, an embedded vision system equipped with a low-resolution camera and a convolutional neural network (CNN) can detect objects or monitor people in real time while consuming milliwatts of power. Similarly, embedded AI systems can process environmental sensor data to detect gas leaks, vibrations, or temperature anomalies in industrial environments without sending all the data to the cloud. These devices use communication protocols such as Bluetooth Low Energy (BLE), LoRaWAN, or Wi-Fi to exchange critical data when needed, keeping energy consumption and latency minimal. Frameworks like TensorFlow Lite for Microcontrollers, Edge Impulse, and PyTorch Mobile provide tools to train, quantize, and deploy models efficiently to embedded hardware. One of the most exciting trends in this domain is the integration of AI accelerators on-chip, such as Google's Edge TPU or the NXP eIQ, which boost inference speed while keeping power usage low. These developments allow real-time responsiveness, essential for safety-critical systems like autonomous drones, medical monitors, and robotics. In healthcare, AI-enabled embedded wearables.

On-Device Intelligence – AI models such as TinyML and edge AI algorithms allow microcontrollers and single-board computers to run inference tasks (image classification, speech recognition, anomaly detection, predictive maintenance, etc.) directly on the device.

Low Power Consumption – Energy-efficient microcontrollers and AI accelerators make it feasible for battery-operated or energy-harvesting systems to perform real-time processing without frequent recharging.

Reduced Latency – Since data processing occurs locally, the system can respond almost instantaneously, which is crucial for applications like autonomous robots, drones, wearable health monitors, or industrial control systems.

Data Privacy & Security – Processing data at the edge minimizes the transmission of sensitive information to external servers, reducing privacy risks and exposure to cyberattacks.

Cost Efficiency – Lower bandwidth usage and reduced dependence on high-end servers or cloud subscriptions can cut operational costs significantly

PRETHICKSHA R
IV YR A SEC

6G COMMUNICATION RESEARCH

6G communication research, which gained strong momentum during 2022–2023, represents the next major leap in wireless communication technology beyond 5G, with goals of achieving ultra-high data rates (up to 1 Tbps), sub-millisecond latency, massive device connectivity, and true real-time responsiveness for advanced applications like holographic communication, intelligent robotics, and immersive extended reality (XR).

Unlike 5G, which focuses on enhanced mobile broadband and industrial IoT, 6G aims to integrate AI at the core of its infrastructure to create self-optimizing, adaptive, and intelligent networks capable of context-aware service delivery. One of the central enablers of 6G is the exploration of Terahertz (THz) frequency bands (100 GHz to 10 THz), which offer massive bandwidths that are orders of magnitude larger than what's available in the sub-6 GHz and mmWave bands used in 5G. This shift, however, introduces challenges like high propagation losses and limited range, requiring the development of new materials, antennas, and signal processing techniques. Intelligent Reflecting Surfaces (IRS)

RANJITHKUMAR K
III YR A SEC

FLEXIBLE & PRINTED ELECTRONICS

Flexible and printed electronics emerged as a transformative trend during 2022–2023, driven by the demand for lightweight, bendable, stretchable, and low-cost electronic devices that can seamlessly integrate into everyday objects, fabrics, and even the human body. Unlike traditional rigid silicon-based circuits, flexible electronics use substrates like plastic, paper, or polymer films that allow circuits to be deformed without losing functionality. This opens up a vast range of applications in wearables, biomedical sensors, foldable smartphones, electronic skin, smart packaging, and soft robotics. Printed electronics, a subset of flexible electronics, involve the use of specialized conductive inks (such as silver nanoparticle, carbon nanotube, or graphene-based inks) printed onto flexible substrates using techniques like inkjet, screen, or gravure printing. These processes enable large-area, low-cost, roll-to-roll manufacturing of circuits, sensors, antennas, and energy-harvesting components. In healthcare, printed biosensors on bandages or patches can monitor vital signs such as glucose, sweat, hydration, or ECG in real-time, transmitting the data wirelessly to smartphones or medical systems for remote diagnostics. In consumer electronics, flexible OLED displays and foldable screens gained traction, seen in advanced smartphones, tablets, and even rollable TVs. Meanwhile, electronic skin (e-skin) made from stretchable sensors can replicate the sense of touch, pressure, or temperature, making it vital for next-generation prosthetics and robotic systems. The integration of flexible energy storage such as thin-film lithium batteries and supercapacitors further enhances the autonomy of such systems. These technologies are also being used in smart textiles, where sensors and circuits are woven into fabrics to monitor posture, muscle movement, or detect falls in elderly patients. In industrial settings, flexible sensor arrays are used for structural health monitoring of bridges, pipelines, and aerospace components, detecting strain, vibration, or cracks in real time. The Environmental applications include printed gas sensors for pollution tracking and flexible solar panels that conform to curved surfaces like tents, vehicles, or clothing. One major advantage of printed electronics is their eco-friendliness; some inks are biodegradable or recyclable, aligning with global sustainability goals. However, challenges remain in terms of performance limitations compared to conventional electronics, including lower carrier mobility, resolution, and long-term stability of printed components. Research is ongoing to develop new materials like organic semiconductors, hybrid perovskites, and graphene to overcome these barriers.

RAVIRAJ P A
III YR C SEC

NEXT-GENERATION BATTERY TECHNOLOGIES

Next-generation battery technologies have become a central focus of innovation across the electronics industry during 2022–2023, aiming to meet the growing demand for safer, longer-lasting, faster-charging, and environmentally sustainable energy storage solutions that can power electric vehicles (EVs), portable devices, wearables, smart homes, and renewable energy systems. Traditional lithium-ion (Li-ion) batteries, while widely used, have limitations in terms of energy density, charge time, thermal stability, and degradation over time. This has driven intensive global research into alternative chemistries such as solid-state batteries, lithium-sulfur (Li-S), lithium-air (Li-O2), sodium-ion, and even zinc-based and graphene-enhanced batteries. Solid-state batteries, one of the most promising advancements, replace the flammable liquid electrolyte found in Li-ion cells with a solid electrolyte, making the battery safer and more compact, while also increasing energy density and reducing leakage or fire risks. These batteries are highly suitable for EVs and aerospace applications, with companies like Toyota and Quantum Scape pushing toward commercialization. Lithium-sulfur batteries, on the other hand, offer theoretical energy densities five times greater than conventional Li-ion, which could revolutionize portable electronics and aviation if challenges like sulfur's short cycle life and volumetric changes can be overcome. Meanwhile, sodium-ion batteries are emerging as a cost-effective and abundant alternative, especially for grid storage, since sodium is far more available and cheaper than lithium. Startups and research labs are also exploring lithium-air batteries that mimic the process of respiration, potentially achieving energy densities close to that of gasoline, ideal for next-gen drones and electric aircraft. Graphene-based batteries, though still largely in the research stage, promise ultra-fast charging, high conductivity, and better thermal management. In parallel, flexible and thin-film batteries are being developed to power bendable electronics and medical implants.

SANGEETHASREE P
II YR A SEC

EDGE AI COMPUTING

Edge AI Computing, which gained significant attention in 2022–2023, refers to the integration of artificial intelligence (AI) capabilities directly onto edge devices such as smartphones, sensors, cameras, drones, wearables, and industrial machines so they can process data locally without depending heavily on cloud servers. This trend addresses critical challenges in modern electronics, including latency, bandwidth limitations, energy consumption, data privacy, and real-time responsiveness. Unlike traditional AI systems that send data to distant cloud centers for processing, Edge AI enables immediate decision- making at the source of data generation, which is vital for time-sensitive applications like autonomous vehicles, predictive maintenance in factories, smart surveillance, and health monitoring systems. This decentralization of computing helps reduce latency to milliseconds, improves reliability even in areas with poor connectivity, and ensures data stays secure and private at the local level. Advances in hardware, such as specialized AI chips like Google's Edge TPU, NVIDIA's Jetson, Apple's Neural Engine, and Intel's Movidius, have made it possible to deploy complex AI models like convolutional neural networks (CNNs) and transformers on small, energy-efficient devices. Additionally, software frameworks like TensorFlow Lite, PyTorch Mobile, and ONNX Runtime are enabling developers to train models in the cloud and deploy optimized, compressed versions to edge devices. Techniques like model quantization, pruning, and neural architecture search (NAS) help reduce the size and power requirements of AI models while maintaining accuracy. In the healthcare sector, Edge AI enables real-time analysis of medical data from wearable sensors to detect anomalies like irregular heartbeats or sleep without needing to transmit sensitive data to the cloud. In smart cities, edge-based cameras can detect traffic violations or suspicious behavior instantly, reducing network load and enhancing responsiveness.

SARMINI M
II YR C SEC

CYBERSECURITY FOR HARDWARE SYSTEMS

Cybersecurity for hardware systems emerged as a critical concern in 2022–2023 due to the increasing connectivity of embedded devices, IoT systems, automotive electronics, and smart infrastructures, all of which are vulnerable to sophisticated physical and cyber threats that target the underlying hardware. As electronics become smarter and more networked, attackers are not only exploiting software vulnerabilities but also attacking the hardware layers microprocessors, memory, sensors, and communication modules through methods such as side-channel attacks, fault injection, supply chain tampering, and firmware manipulation. Hardware-level breaches can be catastrophic, allowing attackers to bypass encryption, extract cryptographic keys, take control of critical systems, physical damage. High-profile incidents, such as hardware trojans found in chip supply chains or vulnerabilities like Spectre and Meltdown in processors, have underscored the need for security by design in hardware.

To counter these threats, researchers and industries are incorporating hardware security modules (HSMs), trusted platform modules (TPMs), secure boot mechanisms, and physically unclonable functions (PUFs) into devices, ensuring that each piece of hardware has a unique, tamper-proof identity. Secure boot ensures that only authenticated firmware is loaded during startup, preventing attackers from installing malicious code. Meanwhile, PUFs exploit manufacturing variations to create device-unique keys without storing them in memory, making them highly resistant to cloning or tampering. Techniques like logic locking and obfuscation are being used in chip design to prevent reverse engineering and intellectual property theft. In the automotive industry, hardware security is vital for ensuring the safety of an autonomous and connected vehicles, which rely on secure microcontrollers to prevent remote hacking of steering, braking, or infotainment systems. Similarly, in medical devices like pacemakers and insulin pumps, unauthorized access could have life-threatening consequences, demanding robust, low-power hardware-level encryption and access control mechanisms. Industrial automation systems (ICS) and critical infrastructure like power grids and water treatment facilities also require strong embedded security, as attacks could disrupt national services. To address such risks, governments and standard bodies have introduced certifications like Common Criteria (ISO/IEC 15408), FIPS 140-3, and NIST’s Cybersecurity Framework to ensure hardware meets security benchmarks.

The rise of quantum computing has also prompted research into post-quantum cryptography for hardware systems, preparing for a future where current encryption methods may become obsolete. Additionally, hardware-assisted machine learning models are being developed to detect anomalies and intrusions in real time, providing a hybrid defense that leverages both AI and hardware features.

As embedded devices permeate every aspect of modern life—from personal healthcare to industrial automation—the stakes for hardware security have never been higher. By integrating technologies like HSMs, TPMs, PUFs, and secure boot mechanisms, along with adhering to established standards, industries can create devices that are not only functional but also resilient against evolving cyber threats. This proactive approach reduces long-term risk, protects sensitive data, and safeguards public safety in an increasingly interconnected world.

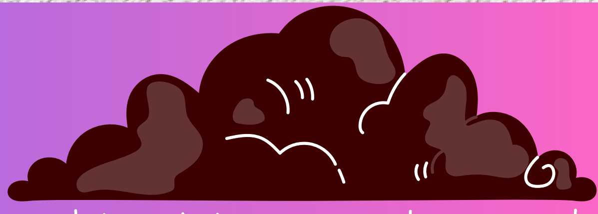
SINDUJA R
III YR A SEC

POETRY

The Clock That Forgot

A clock once ticked in perfect rhyme,
Then lost its place in counting time.
It told the flowers, “Bloom at will,”
And told the moon to linger still.
Days tangled up with nights like thread,
Cats slept where morning ought to spread.
And though the world was quite askew,
It somehow felt more honest too.

PRAVEEN S
III YR A SEC



The Library of Rain

Beneath the roofs of dripping slate,
A library sleeps, the books all wait.
Each page is damp, each word is blurred,
Yet somehow still the tales are heard.
A whisper rises, paper-thin,
Of storms outside, and storms within
And every drop that strikes the pane
Is just another line of rain.

SERU MOUNIKA
II YR C SEC

Tea with a Cloud

I invited a cloud for afternoon tea,
It arrived in a puff and sat across from me.
We sipped on rain with a dash of light,
And traded dreams from last night’s night.
It spoke of winds and silver seas,
Of dancing leaves and thunder’s sneeze
Then left, all mist and drifting white,
Promising fog by Thursday night.

SRI PRIYADARSHINI B
III YR C SEC

The River Remembers

A river once whispered my name to the stones,
It carried my secrets in murmuring tones.
It curved through the fields where wildflowers bow,
And mirrored the sky on the sweep of its brow.
It spoke of the past in a voice soft and low,
Of places I’d been but would never quite know.
And though I kept walking, its song followed me,
A thread through the fabric of memory’s sea.

SRINIVASAN B
IV YR C SEC

Lanterns

In the hush between dusk and the rise of the moon,
The lanterns awaken, their flames in tune.
They sway with the breath of the evening air,
Guiding lost moths with a tender glare.
Each light holds a wish someone dared to send,
Drifting toward night with no certain end.
And stars lean low just to watch them burn,
Until every lantern forgets to return.

SUVATHA V
I YR C SEC

The Last Train

The platform hums with a hollow sound,
No voices remain, no footsteps pound.
The train waits patient, its windows dim,
A sigh in its breath, a metallic hymn.
It carries no passengers, only the rain,
Through tunnels that echo like half-formed pain.
And somewhere ahead, the night bends wide
But never enough for the dawn to ride.

SARMINI M
II YR B SEC

THE CLOCK THAT RAN BACKWARDS

Marlowe couldn't sleep. Every night after closing the pawnshop, he sat in the corner staring at the brass clock. The backward sweep of its hands was hypnotic, each tick pulling him closer to something he couldn't name. The first time he touched it, the world outside had rolled back twenty years, and the thrill of that discovery still burned in his mind. He had tested it in increments five minutes, an hour, a full day and every time, the rewound world was seamless, as if reality itself had agreed to lie. But tonight, something was wrong. He hadn't touched the clock since rewinding to the day before his birth, and yet it kept ticking backwards on its own. He tried to push the hands forward nothing. The brass felt warm under his palms, as though it were alive, resisting him. Outside, the city seemed subtly different. A modern apartment block across the street was gone, replaced by a smaller brick building with peeling paint. The fashion of the passersby was different. Even the smell of the air was changing cleaner, sharper, almost metallic. Days passed, and Marlowe realized the clock was eating time at a steady pace: two hours of history vanished for every one hour he lived. He could watch history unmake itself new buildings disappearing, cars vanishing into cobblestone streets, electric lights giving way to gas lamps. People changed too. Neighbors he'd spoken to the day before didn't recognize him the next. Some simply weren't there anymore. Panic set in. He scoured the shop for clues old ledgers, hidden compartments, anything that could explain the clock's origin. In the deepest drawer, wrapped in crumbling cloth, he found a faded photograph of the shop as it had been a century ago. In the picture, the same brass clock sat on the counter, but behind it stood a man who looked exactly like Marlowe. The truth hit him with a sickening weight. This wasn't just a clock it was a tether, binding him to a loop he had already lived, countless times before. Every "rewind" wasn't his discovery it was his curse. And now, for reasons he didn't understand, the loop was collapsing faster than ever.One evening, the gas lamps outside flickered and vanished, replaced by torches. The world was slipping back into an age before cities, before language, before humans. Standing alone in the dim shop, Marlowe placed his hands on the clock and considered the only choice left to him: break it and end the cycle forever… or let the world keep unraveling, until even he was gone.

SARMINI M
II YR B SEC

A HAUNTED LEGACY

Under the pale glow of the lantern, Meera sat alone in her late grandmother's house, a place she hadn't visited in over a decade, its wooden beams groaning in protest at the midnight wind. She had come to sort through old belongings, but the moment she stepped inside, the air felt heavier, almost watchful, and the scent of jasmine her grandmother's favorite lingered though no flowers bloomed nearby. As she opened a dust-coated trunk, she found a small music box carved with strange symbols she didn't remember, its brass key cold to the touch. Out of habit, she wound it, and the delicate tune began to play, slow and haunting, filling the empty rooms like a whisper from another time. Then she heard it soft footsteps in the hallway, too deliberate to be the wind. Heart pounding, she called out, but only silence answered, until the music slowed, warping as though time itself bent. Turning toward the doorway, she froze; a shadow stood there, tall and still, and as her eyes adjusted, she recognized the thin frame and white sari of her grandmother. The figure smiled faintly, lips moving without sound, then lifted a hand and pointed toward the far wall. Drawn by something she couldn't resist, Meera followed the gesture, pressing her palm to the spot, where the wallpaper peeled away to reveal a hidden compartment containing a faded photograph of a young woman she'd never seen yet whose eyes were unmistakably her own. The air grew colder, the jasmine scent thickening until it choked her, and the shadow stepped closer, whispering now, the words slithering into her mind: "She's still waiting." Before Meera could speak, the lantern sputtered and died, plunging the house into darkness, and the music box wound itself, playing that same warped tune. She ran outside into the rain, clutching the photograph, but when she turned back, the house's windows glowed faintly with golden light, silhouettes moving inside though she had locked the door behind her. In the morning, the neighbors told her the house had been abandoned since her grandmother's death and that no light had shone there in years. Still, the photograph in her hand remained warm, and faintly, beneath the noise of the waking street, she could hear the music box playing somewhere far away.

RUBERT MAJALA G
III YR C SEC

EDITOR PANEL

EDITOR IN CHIEF

Dr. P. Raja
Professor and Head,Dept. of ECE

STAFF COORDINATOR

Ms. A. Preetha
Assistant Professor, Dept. of ECE

STUDENT EDITORS

1. **GOWTHAM S**
   II YR B SEC
2. **KEERTHISHA V**
   III YR C SEC
3. **NITHISH S**
   III YR A SEC
4. **PRAVEEN S**
   II YR B SEC
5. **SINDUJA R**
   I YR A SEC
6. **RAGHAVARDHINI K**
   IV YR A SEC
7. **SHIRISH S**
   IV YR B SEC
8. **PAVITHRA B**
   III YR A SEC
9. **YAMUNA V**
   I YR C SEC

SRI MANAKULA VINAYAGAR ENGINEERING COLLEGE
PONDICHERRY
ACHIEVE THROUGH TECHNOLOGY