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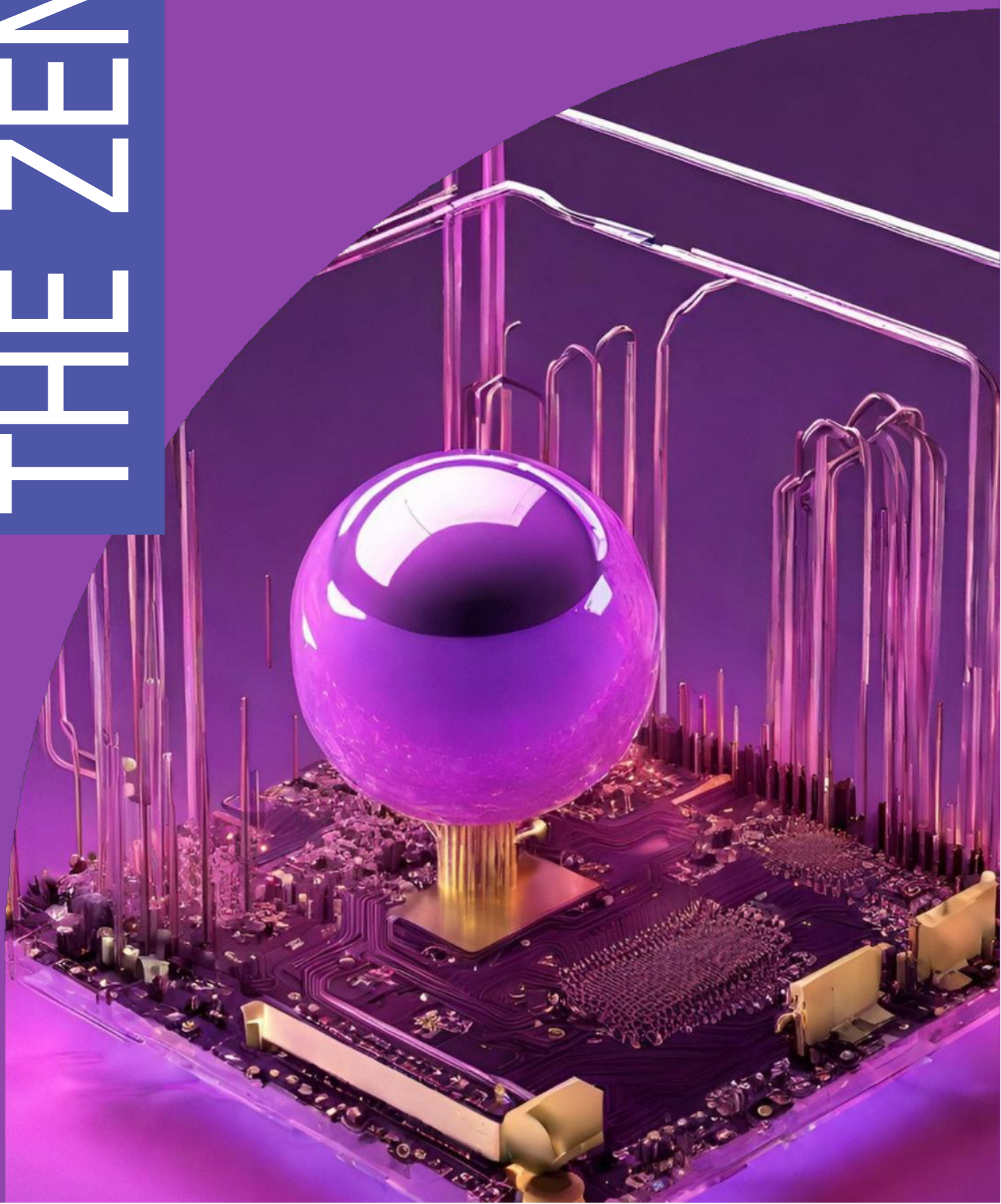

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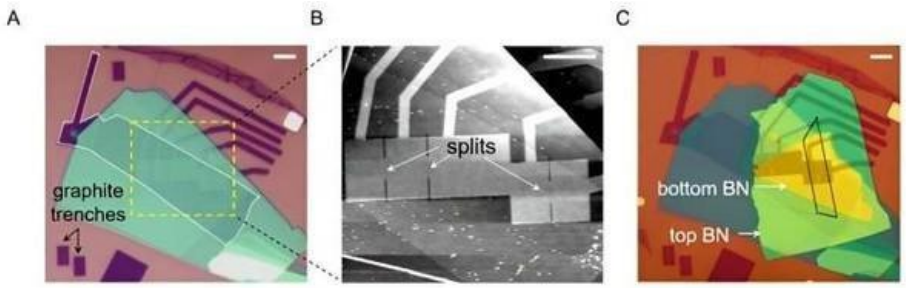
'Kink state' control may provide pathway to quantum electronics



Device fabrication. A, An optical image of the K22 stack including the etched graphite bottom split gates and trenches made for alignment. The white dashed line outlines the graphite global gate (GG). B, AFM image of the area inside the yellow box in A. In areas of interest, the surface is clean of polymer residue. The widths of the splits vary from 74 to 90 nm, as measured by AFM. C, An optical image of K22 after the transfer of the h-BN/BLG/h-BN stack. Credit: Science (2024).

The key to developing quantum electronics may have a few kinks. According to researchers, that's not a bad thing when it comes to the precise control needed to fabricate and operate such devices, including advanced sensors and lasers. The researchers fabricated a switch to turn on and off the presence of kink states, which are electrical conduction pathways at the edge of semiconducting materials.

The key to developing quantum electronics may have a few kinks. According to a team led by researchers at Penn State, that's not a bad thing when it comes to the precise control needed to fabricate and operate such devices, including advanced sensors and lasers. The researchers fabricated a switch to turn on and off the presence of kink states, which are electrical conduction pathways at the edge of semiconducting materials. By controlling the formation of the kink states, researchers can regulate the flow of electrons in a quantum system.

"We envision the construction of a quantum interconnect network using the kink states as the backbone," said team leader Jun Zhu, professor of physics at Penn State. Zhu is also affiliated with Penn State's Center for 2-Dimensional Layered Materials. "Such a network may be used to carry quantum information on-chip over a long distance, for which a classical copper wire won't work because it has resistance and therefore cannot maintain quantum coherence."

The work, published recently in Science, potentially provides a foundation for researchers to continue investigating kink states and their application in electron quantum optics devices and quantum computers.

"This switch operates differently from a conventional switch, where the electrical current is regulated through a gate, similarly to traffic through a toll plaza," Zhu said. "Here, we are removing and rebuilding the road itself."

'Kink state' control may provide pathway to quantum electronics

Kink states exist in a quantum device built with a material known as Bernal bilayer graphene. This comprises two layers of atomically thin carbon stacked together, in such a way that the atoms in one layer are misaligned to the atoms in the other. This arrangement, together with the use of an electric field, creates unusual electronic properties -- including the quantum valley Hall effect. This effect refers to the phenomenon of electrons occupying different "valley" states -- identified based on their energy in relation to their momentum -- also move in opposing forward and backward directions. Kink states are manifestations of the quantum valley Hall effect. "The amazing thing about our devices is that we can make electrons moving in opposite directions not collide with one another -- which is called backscattering -- even though they share the same pathways," said first author Ke Huang, a graduate student pursing a doctorate in physics at Penn State under Zhu's mentorship. "This corresponds to the observation of a 'quantized' resistance value, which is key to the potential application of the kink states as quantum wires to transmit quantum information." While the Zhu lab has published on the kink states before, they only achieved the quantization of the quantum valley Hall effect in the current work after improving the electronic cleanness of the devices, meaning they removed sources that could allow electrons moving in opposite directions to collide. They did this by incorporating a clean graphite/hexagonal boron nitride stack as a global gate -- or a mechanism that can allow the flow of electrons -- into the devices. Both graphite and hexagonal boron nitride are compounds commonly used as lubricant for paints, cosmetics and more. Graphite conducts electricity well while hexagonal boron nitride is an insulator. The researchers used this combination to contain electrons to the kink states and control their flow. "The incorporation of a graphite/hexagonal boron nitride stack as a global gate is critically important to the elimination of electron backscattering," Huang said, noting that this material use was the key technical advancement of the current study. The researchers also found that the quantization of the kink states remains even when the temperature is raised to several tens of Kelvin, the scientific unit of temperature. Zero Kelvin corresponds to -460 degrees Fahrenheit. "Quantum effects are often fragile and only survive at cryogenic temperatures of a few Kelvin," Zhu said. "The higher temperature we can make this work, the more likely it can be used in applications." The researchers experimentally tested the switch they built and found that it could quickly and repeatedly control the current flow. This adds to the arsenal of kink state-based quantum electronics widgets that help control and direct electrons -- valve, waveguide, beam splitter -- previously built by the Zhu lab.

'Kink state' control may provide pathway to quantum electronics

"We have developed a quantum highway system that could carry electrons without collision, be programmed to direct current flow and is potentially scalable -- all of which lays a strong foundation for future studies exploring the fundamental science and application potentials of this system," Zhu said. "Of course, to realize a quantum interconnect system, we still have a long way to go." Zhu noted that her lab's next goal is demonstrate how electrons behave like coherent waves when traveling on the kink state highways.

Other authors include Hailong Fu, a former postdoctoral scholar and Eberly Fellow in physics at Penn State, and a current assistant professor at Zhejiang University, China; and Kenji Watanabe and Takashi Taniguchi, both with the National Institute for Materials Science in Japan.

Science Daily July 25, 2024
Source: Penn State

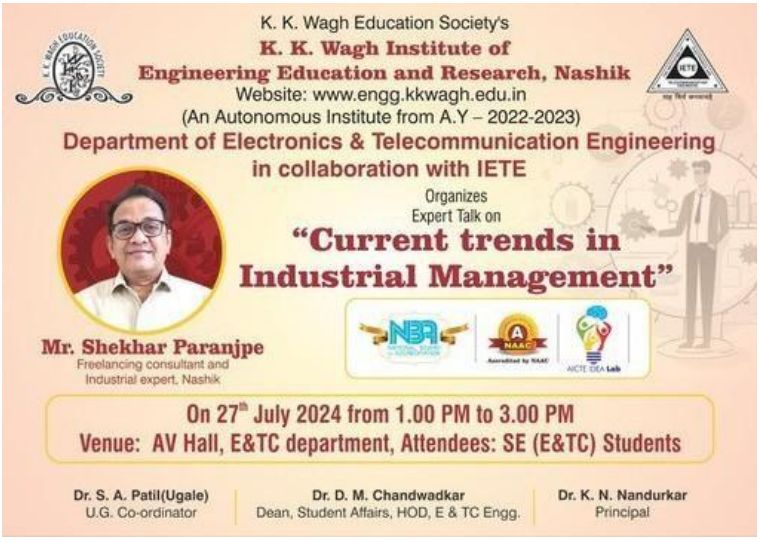
Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, organized an Expert talk on "MicroPython Basics" by Dr. Pravin Wankhede (Associate Professor, CSMSS Chh. Shahu College of Engineering, Chhatrapati Sambhajinagar) on 20TH July 2024 from 03:00 pm to 05:00pm.

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, in collaboration with IETE Nashik subcenter organized an Expert talk on "Project Selection Guidelines" by Er. Jagdish Ugale (Deputy Manager R&D, Thermo Fisher Scientific) on 27th July 2024, Saturday at 10:30 am.

Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, in collaboration with IETE Nashik subcenter organized an Expert talk on “Current trends in Industrial Management” by Mr. Shekhar Paranjpe (Freelancing Consultant and Industrial expert, Nashik) on 27th July 2024, from 01:00 pm to 03:00 pm.



- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, in collaboration with IETE Nashik subcenter organized Panel Discussion on “Scope & Career Opportunities in Electronics & Telecommunication Engineering” by Mr. Ganesh Baviskar, Dr.Shrinivas P. Mahajan, Mr. A. R. Chandrashekhar, Mr. Sachin Kulkarni, Mr. Archan Oak and Ms. Akshada Patel on9th August 2024, at 03:00 pm.

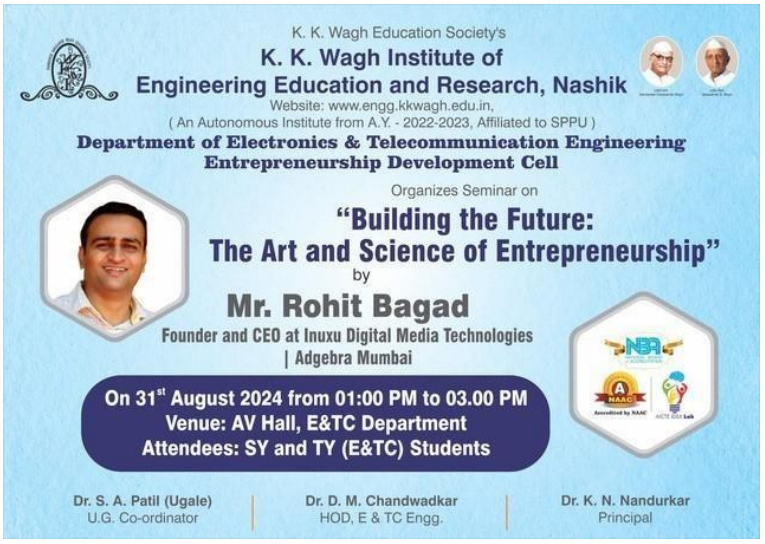
Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, in collaboration with IETE Nashik subcenter organized an Expert talk on “Different types of Cyber Crime” by Mr. Tanmay Diksheet on 16th August 2024 from 01:00 pm to 03:00pm.

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, in collaboration with IETE Nashik subcenter organized an Expert talk on “Guidance Session on Placement Preparation for Emerson” by Ms. Pooja Hiremath (System Engineer, Emerson Export Engg Center, Nashik) on 17th August 2024, from 01:00 pm to 03:00pm.

Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, in collaboration with IETE Nashik subcenter organized an Expert talk on “Building the Future: The Art and Science of Entrepreneurship” by Mr. Rohit Bagad on 31st August 2024, from 01:00 pm to 03:00pm.



- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, in collaboration with IETE Nashik subcenter, organized a workshop on Mastering AI and deep Learning in MATLAB: A hands-on approach from exploration to deployment by Mr. Kunal Khandelwal from 5th to 6th August, 2024 from 10:00 pm to 04:00pm.

Industrial Visit of TY Btech students to Giant MetreWave Radio Telescope (GMRT NCRA-TIFR), Narayangaon Conducted By Mrs. S. D. Raut on 19th July 2024 from.

Industrial Visit of TY BTech E&TC students to GMRT on 19th July 2024

Industrial Visit of TY BTech E&TC students (Div A and B) to GMRT on 19th July 2024

Industrial Visit of B.E. Btech students to AADD Technologies, Nashik, Maharashtra 422403 Conducted by Mrs. Iramsaba Sayyed and guided by Mr. Prasant Pandurang Pawar (Directors of AADD Technologies Private Limited) on 27th September 2024.

Achievements of Students / Teachers / staff

An alumnus of the E&TC branch of K. K. Wagh, Shri Aniket Arya achieved the highest marks and secured the first position in the B.E. (Electronics) Examination held in April/May 2021 at Savitribai Phule Pune University. He was awarded the 'Dr. D.Y. Patil Gold Medal' and the 'Late Mandar Shripad Sant Gold Medal' on July 3, 2024, during the 124th Convocation Ceremony.

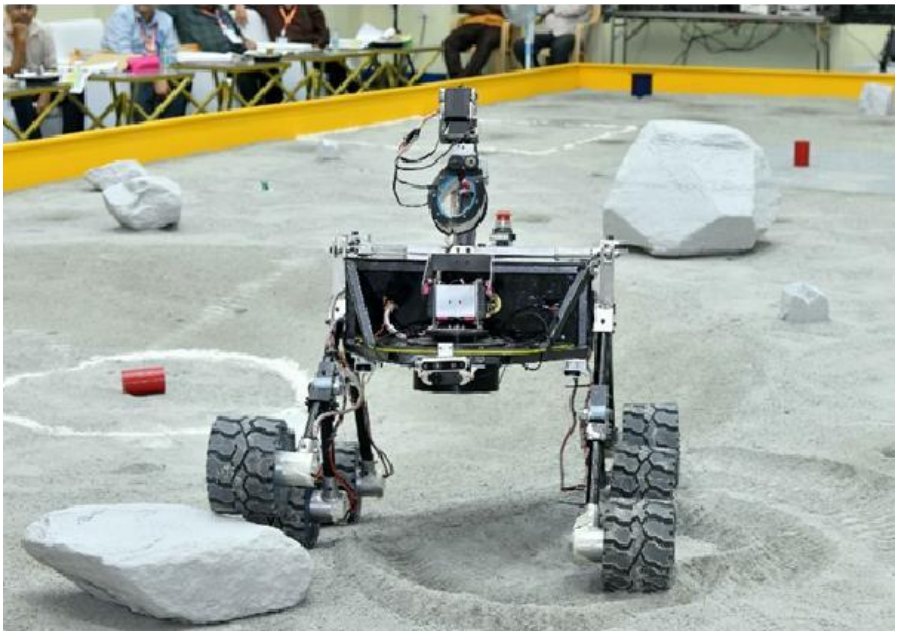

Savitribai Phule Pune University
(Formerly University of Pune)
Gold Medal Award
This is to certify that
Shri. / Smt. Aniket Arya
has secured highest number of marks and
stood first at B. E. (Electronics)
Examination held
in Apr/May 2021 of this University.
He / She has been awarded Gold Medals.
" Dr. D. Y. Patil Gold Medal "
"Late Mandar Shripad Sant Gold Medal"
Director
Board of Examinations & Evaluation
Vice-Chancellor
Date : 3rd July 2024

Achievements of Students / Teachers / staff

Team Vayuasta of Dept E&TC and Mechanical has participated and won Third Prize in Group-A for model titles Multipurpose Surveillance & Expendable UAV Sponsored by legrand India in the 21st National level working Competition Organized by Dept of Electrical Engineering, K. K. Wagh, Nashik in association with IET Nashik Local Network during April 5-6, 2024.

Achievements of Students / Teachers / staff

Team Matrix is an interdisciplinary team from our college that competes in robotics competitions. This year, students from our department played a pivotal role in the team's success.
They secured 7th place in the ISRO Robotics Challenge and 2nd place at National Robotex Tanmay Gajkal and Pranav Bachhav (TY BTech Div B)



Achievements of Students / Teachers / staff

Ritesh Sakhare (TY E&TC) got selected for the Kleos hackathon at D.Y. Patil, Navi Mumbai. It was a National Hackathon where top national institute participated in round 1 and only top 30 teams selected from all in which there were IIT's, NIT's and one team from K.K. Wagh College itself. Secured 5th Rank in top 30.
Event held in June 2024

Achievements of Students / Teachers / staff

Ritesh Sakhare (TY E&TC) got selected for the Live Project competition at ABB Pvt. Ltd.

Achievements of Students / Teachers / staff

Congratulations to Ms. Unnati Bhadani, an outstanding B.E. E&TC graduate, for securing Rank-1 across all branches at Savitribai Phule Pune University in May 2023 with a perfect CGPA of 10.

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Editor: Prof. Snehal D. Raut
Email: sdraut@kkwagh.edu.in

EDITORS

- **Krish Makwane**
- **Tejashri Mahajan**
- **Pankaj Pardeshi**
- **Saloni Ahire**

VISION

Excel in quality technical education and research in Electronics and Telecommunication (E&TC) Engineering for sustainable development of industry and betterment of society.

MISSION

M1: To provide quality education for the preparation of technically and professionally competent E&TC engineers.

M2**:** To create an environment to enhance life-long learning and 21st century skills

M3**:** To inspire students' innovative thinking and creativity to promote research culture**.**