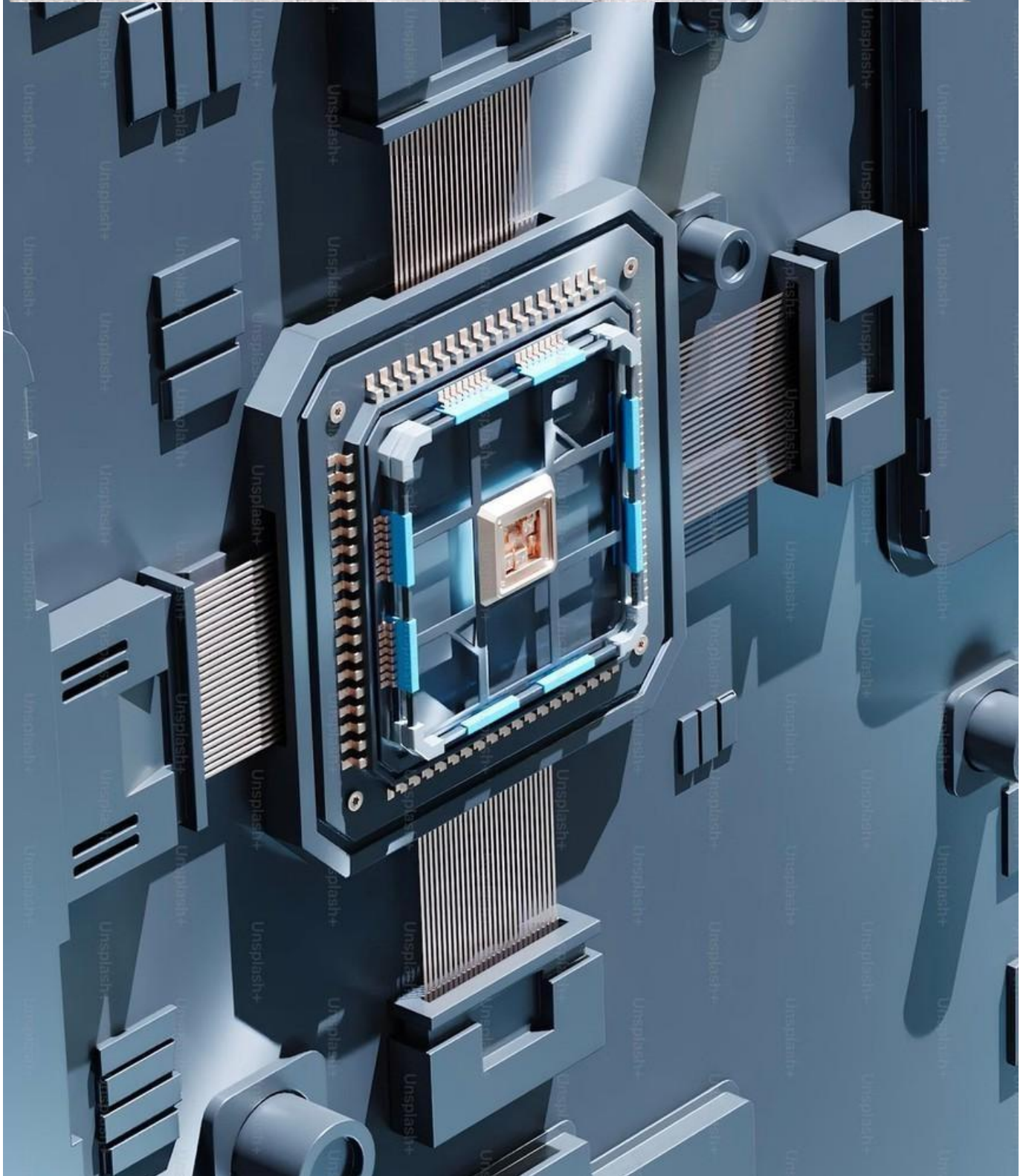


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Electrical control of quantum phenomenon could improve future electronic devices

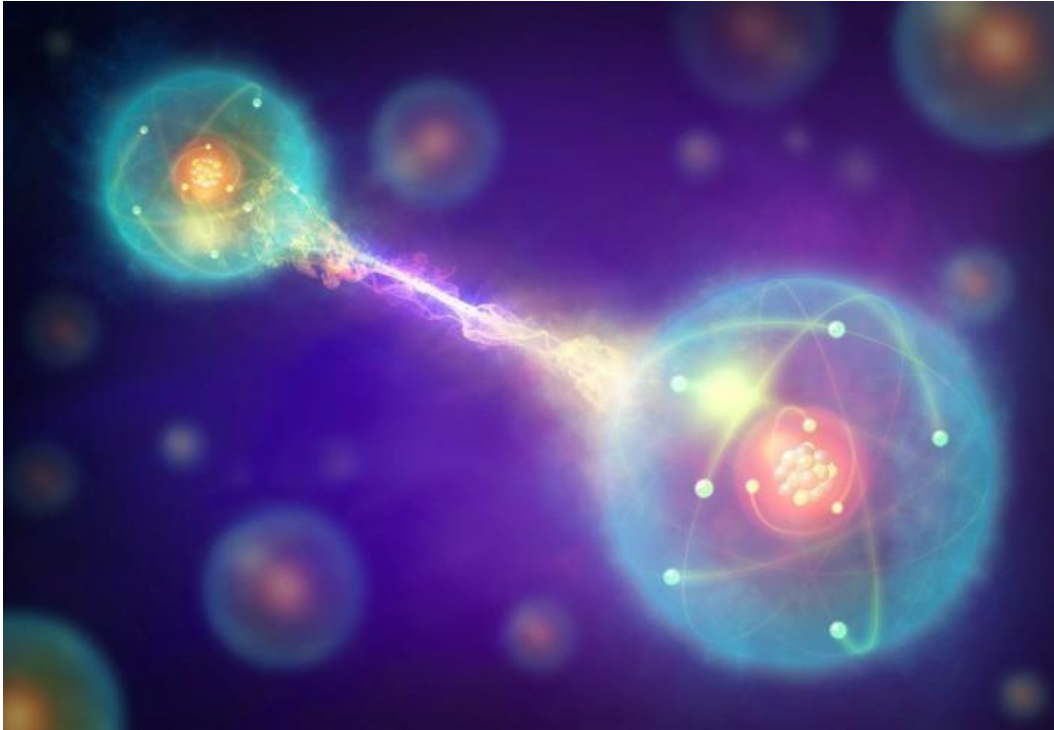


Image Credits: Popular Mechanics

A new electrical method to conveniently change the direction of electron flow in some quantum materials could have implications for the development of next-generation electronic devices and quantum computers. A team of researchers from Penn State developed and demonstrated the method in materials that exhibit the quantum anomalous Hall (QAH) effect -- a phenomenon in which the flow of electrons along the edge of a material does not lose energy. The team described the work in a paper appearing (Oct. 19) in the journal *Nature Materials*.

"As electronic devices get smaller and computational demands get larger, it is increasingly important to find ways to improve the efficiency of information transfer, which includes the control of electron flow," said Cui-Zu Chang, Henry W. Knerr Early Career Professor and associate professor of physics at Penn State and co-corresponding author of the paper. "The QAH effect is promising because there is no energy loss as electrons flow along the edges of materials."

In 2013, Chang was the first to experimentally demonstrate this quantum phenomenon. Materials exhibiting this effect are referred to as QAH insulators, which are a type of topological insulator -- a thin layer of film only a couple dozen atoms thick -- that have been made magnetic so that they only conduct current on their edges. Because the electrons travel cleanly in one direction, the effect is referred to as dissipationless, meaning no energy is lost in the form of heat.

Electrical control of quantum phenomenon could improve future electronic devices

"In a QAH insulator, electrons on one side of the material travel in one direction, while those on the other side travel in the opposite direction, like a two-lane highway," Chang said. "Our earlier work demonstrated how to scale up the QAH effect, essentially creating a multilane highway for faster electron transport. In this study, we develop a new electrical method to control the transport direction of the electron highway and provide a way for those electrons to make an immediate U- turn."

The researchers fabricated a QAH insulator with specific, optimized properties. They found that applying a 5-millisecond current pulse to the QAH insulator impacts the internal magnetism of the material and causes the electrons to change directions. The ability to change direction is critical for optimizing information transfer, storage, and retrieval in quantum technologies. Unlike current electronics, where data is stored in a binary state as on or off -- as one or zero -- quantum data can be stored simultaneously in a range of possible states. Changing the flow of electrons is an important step in writing and reading these quantum states.

"The previous method to switch the direction of electron flow relied on an external magnet to alter the material's magnetism, but using magnets in electronic devices is not ideal," said Chao-Xing Liu, professor of physics at Penn State and co-corresponding author of the paper. "Bulky magnets are not practical for small devices like smartphones, and an electronic switch is typically much faster than a magnetic switch. In this work, we found a convenient electronic method to change the direction of electron flow."

The researchers previously optimized the QAH insulator so that they could take advantage of a physical mechanism in the system to control its internal magnetism.

"To make this method effective, we needed to increase the density of the applied current," Liu said. "By narrowing the QAH insulator devices, the current pulse resulted in very high current density that switched the magnetization direction, as well as the direction of the electron transport route." This shift from magnetic to electronic control in quantum materials, according to the researchers, is similar to a shift that has occurred in traditional memory storage: While the storage of information on original hard drives and floppy disks involved the use of magnets to create a magnetic field and write data, newer "flash memory" such as that used in USB drives, solid state hard drives, and smartphones is written electronically. Promising new technologies to scale up memory, such as MRAM, similarly rely on physical mechanisms related to internal magnetism.

Electrical control of quantum phenomenon could improve future electronic devices

Beyond the experimental demonstration, the research team also provided a theoretical interpretation of their methodology. The team is currently exploring how to pause electrons on their route -- to essentially turn the system on and off. They are also pursuing how to demonstrate the QAH effect at higher temperatures.

"This effect, as well as current requirements for quantum computers and superconductors, require very low temperatures near absolute zero," Chang said. "Our long-term goal is to replicate the QAH effect at more technologically relevant temperatures."

In addition to Chang and Liu, the research team at Penn State at the time of the research includes postdoctoral researchers Wei Yuan, Yang Wang, and Hemian Yi; graduate students Ling-Jie Zhou, Kaijie Yang, Yi-Fan Zhao, Ruoxi Zhang, Zijie Yan, Deyi Zhuo, and Ruobing Mei; Morteza Kayyalha, assistant professor of electrical engineering; and Moses Chan, Evan Pugh University Professor Emeritus of Physics.

The Army Research Office, the Air Force Office of Scientific Research, and the National Science Foundation (NSF) funded this research. The NSF-funded Materials Research Science and Engineering Center for Nanoscale Science at Penn State and the Gordon and Betty Moore Foundation's EPiQS Initiative provided additional support.

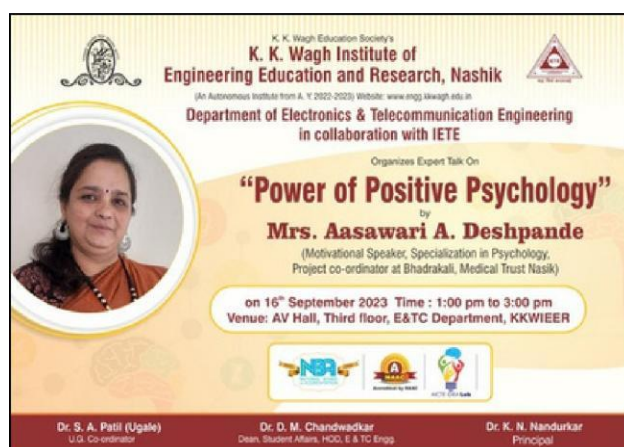
Science Daily
October 19,
2023
Source: Penn State

Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized a workshop on "TINA-TI Introduction" by Mr. Dipankar D. Khartad (IOT Software Developer, ESL Lab, Rishabh Instruments, Nashik) on 16th September 2023.



- Training and Placement Cell and the Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized an expert talk on "Power of Positive Psychology" by Mrs. Aasawari A. Deshpande (Motivational Speaker, Specialization in Psychology, Project co-ordinator at Bhadrakali, Medical Trust Nashik) on 16th September 2023.



Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized an expert talk on “Durg Sanskruti” by Mr. Devdatta Gokhale (Director at Gokhale’s Advanced Training Institute, Jalgaon, ELTIS Certified Trainer in soft skills) on 23rd September 2023.



- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized a workshop on “Web Page Designing” by Mr. Deepakkumar Shinde (Full Stack Developer and Trainer in Confluence Infotech) on 9th October 2023.

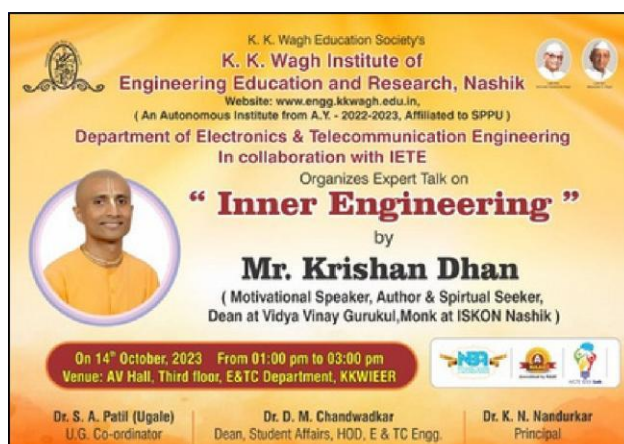


Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized a webinar on “Opportunities in the Electric Vehicle sector” by Mr. Rahul Patil (Sr. Engineer, L&T Technology and Services, Vadodara) on 14th October 2023.



- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized an expert talk on “Inner Engineering” by Mr. Krishan Dhan (Motivational Speaker, Author & Spiritual Seeker, Dean at Vidya Vinay Gurukul, Monk at ISKCON Nashik) on 14th October 2023.

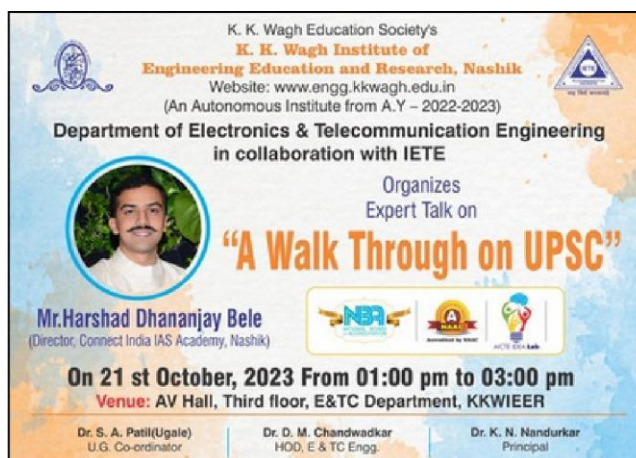


Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized an expert talk on “Web Page Designing: Part 2” by Mr. Deepakkumar Shinde (Full Stack Developer and Trainer in Confluence Infotech) on 16th October 2023.



- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized an expert talk on “A Walk Through on UPSC” by Mr. Harshad Dhananjay Bele (Director, Connect India IAS Academy, Nashik) on 21st October 2023.

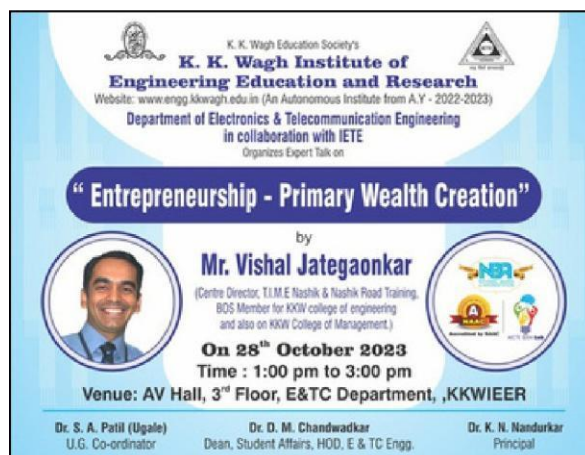


Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized an expert talk on “Channel Coding: Importance of error correction mechanism in noisy environment” by Mr. Shrikant S. Joshi (Assistant Professor, Vishwakarma Institute of Information Technology) on 26th October 2023.



- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized an expert talk on “Entrepreneurship - Primary Wealth Creation” by Mr. Vishal Jategaonkar (Centre Director, T.I.M.E. Nashik & Nashik Road Training, BOS Member for KKW College of Engineering and also on KKW College of Management) on 28th October 2023.



Expert Lectures/Seminars/Courses Organised

- Department of Electronics and Telecommunication Engineering of K. K. Wagh Institute of Engineering Education and Research Nashik, Students' Association of Electronics Engineers (SAEE) in collaboration with IETE Nashik subcenter organized an expert talk on “Need of Electronics as Automation in Industry” by Mr. Sanjay Chaudhari (Director, Electronics Study Centre, Nashik) on 30th October 2023.





Industrial Visits organized by Department for Students



ENTC Division B students eagerly explored Sivananda Electronics during an insightful industrial visit on October 13.



ENTC Division A students eagerly explored Emerson Electric during an insightful industrial visit on October 21.



Training and Placement Cell (Campus Placement)

Sr. No.	Name of Student	Company Name	Package
1.	Akshata Sunil Jadhav	Faurecia	5.5
2.	Pooja Ashokkumar Kulkarni	Faurecia	5.5
3.	Arya Bhausahab Patil	Emerson Export Engineering Centre	4.5
4.	Khushboo Sanjaykumar Singh	Emerson Export Engineering Centre	4.5
5.	Rushikesh Pandurang Khalkar	Emerson Export Engineering Centre	4.5
6.	Shalini Narendra Patil	Emerson Export Engineering Centre	4.5
7.	Siddhi Vinayak Lahamage	Emerson Export Engineering Centre	4.5



Training and Placement Cell (Campus Placement)

Sr. No.	Name of Student	Company Name	Package
1.	Abhishek Avinash Gadwe	KPIT	4.5
2.	Aditi Kamlesh Chavan	KPIT	4.5
3.	Akshada Sanjay Satpute	KPIT	4.5
4.	Aniket Arun Jagtap	KPIT	4.5
5.	Anush Nagesh Devadiga	KPIT	4.5
6.	Arya Bhausahab Patil	KPIT	4.5
7.	Devashree Akash Bhole	KPIT	4.5
8.	Deven Prafulla Patil	KPIT	4.5
9.	Jai Prashant Kasar	KPIT	4.5
10.	Ketan Ramkrishna Surashe	KPIT	4.5

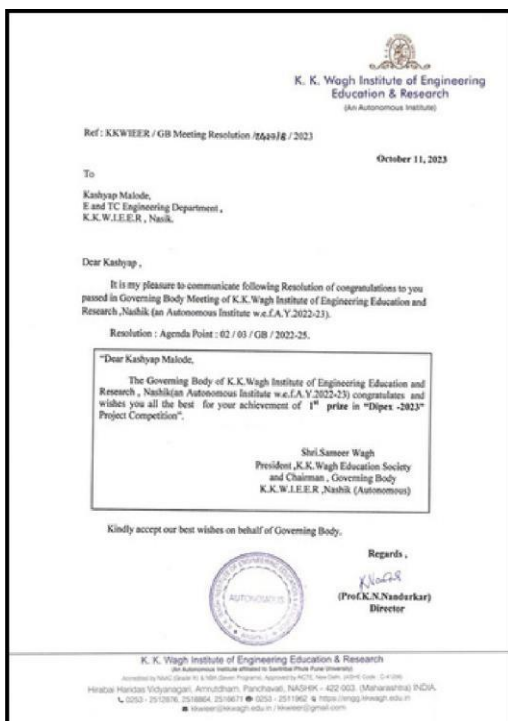
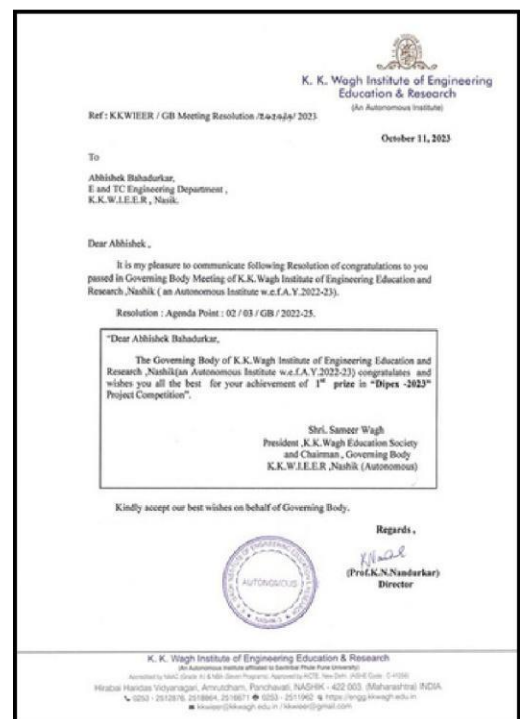
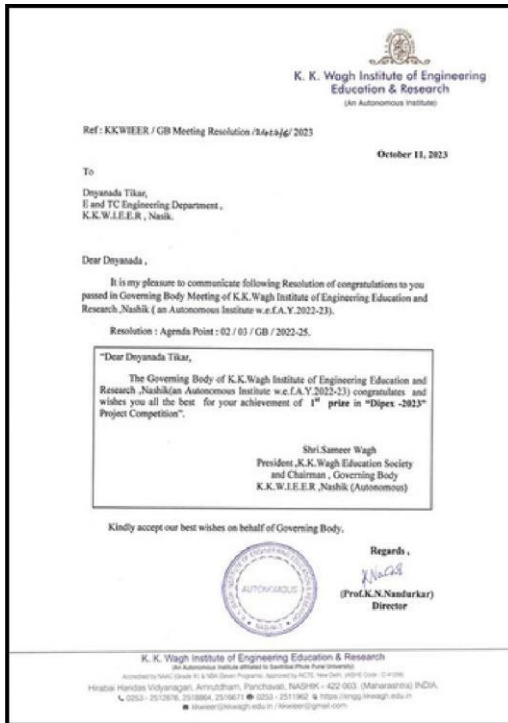


Training and Placement Cell (Campus Placement)

Sr. No.	Name of Student	Company Name	Package
11.	Pavan Sunilrao Ambilwade	KPIT	4.5
12.	Pranali Vidyasagar Pakhale	KPIT	4.5
13.	Pranjal Ravindra Pagar	KPIT	4.5
14.	Samyak Manoj Shingi	KPIT	4.5
15.	Shaunak Prashant Deshpande	KPIT	4.5
16.	Varad Sachin Zodgekar	KPIT	4.5

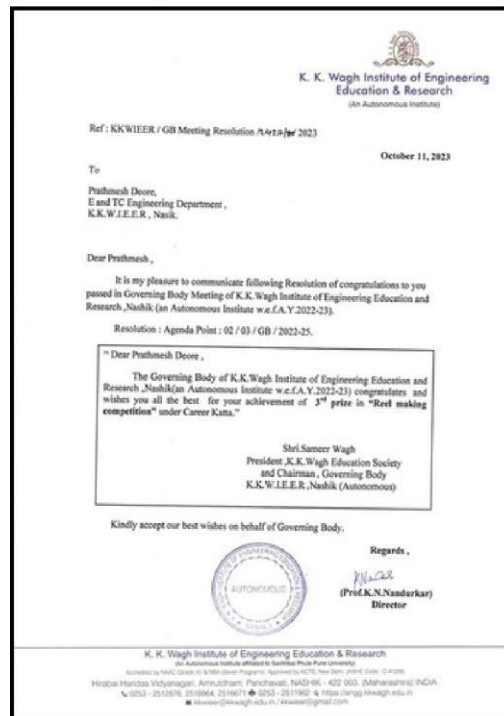
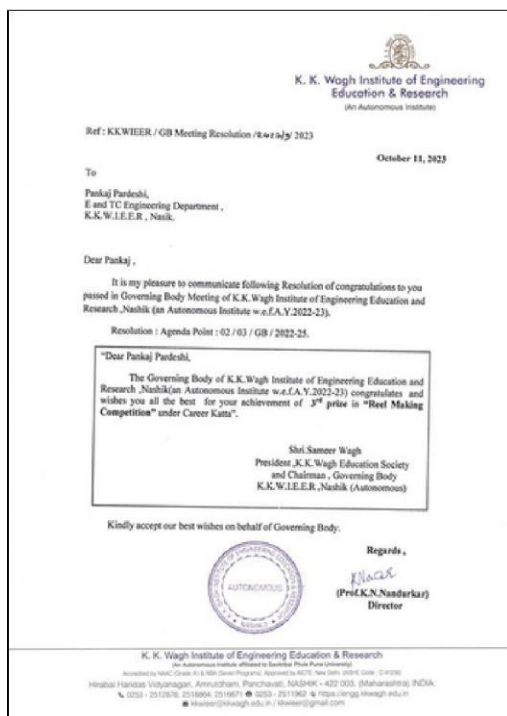
Student Achievements

Abhishek Bahadurkar, Dnyanada Tikar, and Kashyap Malode clinched the first prize in the 'Dipex -2023' Project Competition, and received heartfelt congratulations from the institute's governing body.



Student Achievements

Pankaj Pardeshi and Prathmesh Deore secured 3rd prize in the Reel Making Competition under Career Katta, earning well-deserved congratulations from the institute's governing body.



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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