

KALEIDOSCOPE

Published by
DEPARTMENT OF ELECTRICAL ENGINEERING
JORHAT ENGINEERING COLLEGE
2025-26 EDITION



The Mission of Electrical Engineering Graduate Program is:

- 1.To impart quality technical education at UG, PG and PhD levels.
- 2.To promote continuing effective interactions with academia, alumni and industry.
- 3.To inculcate creativity, societal and ethical values.
- 4.To develop a sustainable learning environment.



VISION

To Develop as a Centre of excellence in electrical engineering for producing competent professionals for sustainable industrial and societal growth



KALEIDOSCOPE

An Annual Magazine of
Department of Electrical Engineering
JORHAT ENGINEERING COLLEGE

**2025-2026
EDITION**

PUBLISHED BY
DEPARTMENT OF
ELECTRICAL ENGINEERING
JORHAT ENGINEERING COLLEGE

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MESSAGE FROM HEAD OF THE DEPARTMENT



Dr. Pranab Jyoti Haloi

As KALEIDOSCOPE 2026, the annual departmental magazine of the Department of Electrical Engineering, Jorhat Engineering College, is set to be published, I am delighted to share a few words on this special occasion. More than just a publication, KALEIDOSCOPE serves as a mirror of our department, reflecting the academic excellence, technical innovations, creative pursuits, and collective achievements of our students and faculty members.

The field of Electrical Engineering is evolving rapidly with remarkable advancements in renewable energy, smart grids, electric mobility, artificial intelligence, automation, and semiconductor technologies. As future engineers, it is essential for our students not only to acquire sound technical knowledge but also to cultivate creativity, critical thinking, leadership, and a commitment to lifelong learning. This magazine provides a platform to showcase these qualities through technical articles, project highlights, literary contributions, artistic expressions, and departmental activities.

The year 2025–26 has been marked by significant accomplishments for our department in academics, research, industry collaboration, and student placements. Such achievements are a testament to the dedication, perseverance, and collaborative spirit of our students, faculty members, alumni, and staff. I hope this edition captures these milestones while inspiring future batches to strive for even greater excellence.

I sincerely appreciate the efforts of the Editorial Board, the Faculty In-Charge, student editors, contributors, and everyone involved in bringing this edition of KALEIDOSCOPE 2026 to fruition. Their commitment and teamwork have made this publication a valuable chronicle of the department's journey and aspirations.

I extend my heartfelt congratulations to all contributors and wish our students continued success in their academic, professional, and personal endeavors. May KALEIDOSCOPE 2026 inspire curiosity, innovation, and excellence while preserving the vibrant legacy of the Department of Electrical Engineering at Jorhat Engineering College.

With best wishes,
Head of the Department
Department of Electrical Engineering
Jorhat Engineering College

MESSAGE FROM FACULTY IN CHARGE



Dr. Bipul Kumar Talukdar

It is a matter of great satisfaction to bring out KALEIDOSCOPE 2026, the annual magazine of the Department of Electrical Engineering, Jorhat Engineering College. This publication reflects the academic pursuits, technical accomplishments, creative talents, and vibrant activities that define our department.

A departmental magazine is more than a collection of articles; it is a repository of ideas, innovation, experiences, and achievements. It provides a meaningful platform for students and faculty members to express their thoughts, share their knowledge, and celebrate the milestones of our academic journey.

This edition of KALEIDOSCOPE is the result of the collective efforts and dedication of our contributors, student editors, faculty members, and the editorial team. I sincerely appreciate their commitment and enthusiasm in making this publication a reality.

I hope KALEIDOSCOPE 2026 will not only preserve the memories and achievements of the academic year but also inspire our students to pursue excellence, embrace innovation, and contribute meaningfully to society.

I extend my best wishes to all our readers and congratulate everyone associated with this.

With best wishes,
Faculty In-Charge
KALEIDOSCOPE 2026
Department of Electrical Engineering
Jorhat Engineering College

FROM THE DESK OF EDITORS



It gives us immense pleasure to present this edition of "Kaleidoscope," the annual magazine of the Department of Electrical Engineering, Jorhat Engineering College. This magazine showcases the academic, technical, research, and extracurricular achievements of our students and faculty throughout the year.

We hope this publication serves as a source of inspiration, innovation, and knowledge while reflecting the spirit and excellence of our department. We sincerely thank everyone who contributed to making this edition possible and wish all our readers an enjoyable and enriching experience.

**Kuldip Patgiri
Shyamalima Saikia
Editors
Department of Electrical Engineering
Jorhat Engineering College**

ACHIEVEMENTS



- **Electrical Engineering Department had become champions in interbranch volley ball tournament 2026.**



- **Electrical Engineering Department had become Runners Up in Interbranch cricket tournament 2026.**

ACHIEVEMENTS



- **Electrical Engineering Department had secured 3rd position in interbranch dance competition 2026.**



- **Electrical Engineering Department had secured 3rd position in interbranch rangoli competition 2025 organized during Diwali.**

ACHIEVEMENTS



Biki Mech from the Department of Electrical Engineering delivered an outstanding performance during Sports Week 2026 by securing:

- **1st Prize in HIGH JUMP**
- **2nd Prize in LONG JUMP**
- **2nd Prize in SHOT PUT**
- **2nd Prize in JAVELIN THROW**

The department congratulates him on his remarkable achievements and wishes him continued success in both sports and academics.

ACHIEVEMENTS



- **Prince Priya Borgohain secured 3rd Prize in Circuithon 3.0 at Technovus 2026, showcasing her technical skills and expertise.**
- **She also secured 2nd Prize in the Republic Day Slogan Writing Competition, held on the occasion of 150 Years of Vande Mataram, reflecting her creativity and literary talent.**
- **Secured 2nd Position in ANIMANGA: Anime Meme Art Competition 2026, showcasing remarkable creativity and artistic talent.**



Pritisha Rani Borah and Nayana Dutta, 4th semester students of the Electrical Engineering Department, secured 1st position in Badminton Doubles during College Week 2026. The department congratulates them on their remarkable achievement and wishes them continued success in all their future endeavours.

ACHIEVEMENTS



- **Prandip Saikia showcased his innovative ideas and secured 1st Prize in Energython, an Idea Pitching Competition held at AEC, reflecting his creativity and innovative spirit.**
- **Prandip Saikia and Swastika Doloj demonstrated remarkable technical skills and teamwork by securing 1st Prize in Circuithon 3.0 and 3rd Prize in Energython 3.0 at JEC.**



- **Chamberlain Gogoi, a 6th semester student of the Electrical Engineering Department, secured 1st Prize in the Slogan Writing Competition organised on the occasion of 150 Years of Vande Mataram. The department congratulates him on this remarkable achievement and wishes him continued success in all his future endeavours.**

ACHIEVEMENTS



Rofiquddin Ahmed from the Department of Electrical Engineering delivered an outstanding performance during Sports Week 2026 by securing:

- 1st Prize in Arm Wrestling (0-55 kg)
- 3rd position in Power lifting (0-59 kg)

The department congratulates him on his remarkable achievements and wishes him continued success in both sports and academics.



Swaraj Mazinder Barua, a 5th-semester student of the Department of Electrical Engineering, Jorhat Engineering College, attended a workshop on “Quantum Computing for 6G” at IIIT Guwahati from 22nd to 23rd March 2025. The workshop was organised under the project “Open RAN for the Next-Gen 6G Communications Using AI-Based Quantum Computing.”

TRAINING AND PLACEMENT RECORDS

VEDANTA Limited

One of India's leading natural resources companies, Vedanta Limited offers excellent career opportunities in mining, metals, and power. The following students secured placements:

- Robi Shankar Kolita
- Deepak Dutta



DALMIA Bharat

A leading Indian industrial group with a strong presence in the cement and manufacturing sectors. Placed Student:

- Dhiroj Saikia



Cavinkare

A renowned Indian FMCG company recognized for its innovative products and dynamic work culture.

Placed Student:

- Dishant Buragohain



TRAINING AND PLACEMENT RECORDS

MRF Limited

A globally recognized tyre manufacturing company, MRF Ltd. is known for its excellence in manufacturing and engineering. The following students were placed:

- Mrigakshi Dowerah
- Bidish Kalita
- Shiva Dey
- Priyam Ranjan Borah
- Dishant Buragohain



High Technext

A company focused on technical services and industrial solutions.

Placed Student:

- Janardon Saikia



HI-TECHNEXT ENGINEERING AND TELECOM PVT. LTD

ORC Private Limited

A reputed organization providing engineering and industrial solutions.

Placed Student:

- Shafique Ali Khandakar



TRAINING AND PLACEMENT RECORDS

Barak & Brazos Engineering Pvt. Ltd.

An engineering consultancy offering services in industrial and infrastructure projects.

Placed Student:

- Prandip Saikia



Brahmaputra Cracker and Polymer Limited (BCPL)

Brahmaputra Cracker and Polymer Limited (BCPL), a Central Public Sector Enterprise under GAIL (India) Limited, is a leading petrochemical company in Northeast India.

Placed Student:

- Jishnu Bordoloi



Glowlogics solutions

A technology-driven company providing innovative software and engineering solutions. The following students secured placements:

- Champak Basumatary
- Riya Sonowal



TRAINING AND PLACEMENT RECORDS

Blinkit

Blinkit, one of India's leading quick-commerce companies, is transforming the way essentials are delivered through technology and efficient logistics.

Placed Student:

- Shiva Dey



PUBLICATIONS

- **Dipli Boruah, Dr. Tilok Boruah, "Ultrafast CMOS-Based On-Chip Islanding Detection for Photovoltaic Microinverters Using Timing-Based Analysis", 3rd IEEE Guwahati Subsection Conference (IEEE-GCON 2026), IIT Guwahati. (Conference Paper)**
- **Dipli Boruah, Dr. Tilok Boruah, "Stochastic Reliability Assessment of Renewable-Dominated Microgrids Incorporating Battery Energy Storage Using Sequential Monte Carlo Simulation", 1st International Conference on Advances in Mechanical and Aerospace Sciences (ICAMAS-2026), NIT Arunachal Pradesh. (Conference Paper)**
- **Dipli Boruah, Tilok Boruah, "Critical Features in AdaBoost Algorithm for Islanding Detection: A Review", 2025 7th International Conference on Energy, Power and Environment (ICEPE), 9 May 2025, DOI: 10.1109/ICEPE65965.2025.11139498. (IEEE Conference Paper)**
- **Dipli Boruah, Tilok Boruah, "Islanding Detection in Microgrids with High Renewable Energy Integration: A Review", National Seminar on Green Energy, Environment and Technology, 16 January 2025. (Conference Presentation)**
- **B. K. Talukdar, "A Probabilistic Approach to Estimate the Operational Effectiveness of a Solar Electric Vehicle", Journal of The Institution of Engineers (India): Series B, Springer Nature, ISSN: 2250-2114, Vol. 102, No. 2, April 2026, DOI: 10.1007/s40031-026-01309-5 [Scopus Indexed Journal]**
- **B. K. Talukdar, P. Roy, "Phase Change Material Application in Photovoltaic Systems: Performance Analysis and Optimization", International Journal of Electrical and Electronics Engineering, ISSN: 2348-8379, February 2026, DOI: 10.14445/23488379/ijeee-v12i10p106 [Scopus Indexed Journal]**
- **B. K. Talukdar, P. Roy, Sandip Bordoloi, B. Talukdar, "Modelling and Analysis of a Hybrid Photovoltaic-Thermoelectric Generator System using a Relative Humidity Adaptive Maximum Power Point Tracking Algorithm", Majlesi Journal of Electrical Engineering, October 2025, DOI: 10.57647/J.MJEE.2025.17717 [Scopus Indexed Journal]**
- **B. K. Talukdar, P. Roy, "A Reliability Centered Framework for Maintainability Analysis of Electric Vehicles", 2025 IEEE Silchar Subsection Conference (SILCON), November 2025, DOI: 10.1109/silcon67893.2025.11327034 [IEEE Conference Paper]**
- **B. K. Talukdar, D. Saikia, A. Phukan, S. Dey, R. Sharma, "Modeling and Analysis of a Solar Integrated Bidirectional Electric Vehicle Charger for Multi-Mode Energy Exchange", 3rd IEEE Guwahati Subsection Conference (GCON 2026), June 2026 [IEEE Conference]**

PUBLICATIONS

- **Pranabjyoti Haloi, Bishnurat Dutta and Jishnu Bordoloi, "A Baseline-Constrained Adaptive Framework for Unsupervised Shot Segmentation of Broadcast News Videos" 3rd IEEE Guwahati Subsection Conference (GCON 2026), being held at IIT Guwahati during June 3–5, 2026**
- **Priyankush Kaushik Baruah., and Pranabjyoti Haloi. "Development and Implementation of a Custom License Plate Detection and Recognition System Using YOLOv10 and Tesseract OCR: A Comprehensive Study in Computer Vision and Optical Character Recognition Technologies." International Journal of Innovative Technology and Exploring Engineering (IJITEE) (2025).**
- **Nandita Medhi, Pranabjyoti Haloi "An Optimized PID Controller Design of Four-Way Valve Controlled Angular Position Servo System Using Ziegler-Nichols Method and Genetic Algorithm" , 2nd International Symposium on Sustainable Energy and Technological Advancements (ISSETA 2023)" organized by Department of Electrical Engineering, National Institute of Technology Meghalaya, Shillong, India during 24th - 25th February 2023.**
- **Niharika Devi, Pranabjyoti Haloi, "Simulation of Symmetrical Conventional Cascaded H Bridge Seven Level Inverter using LC filter with different PWM Techniques for minimization of Total Harmonic Distortion", 1st International Conference on Intelligent Computation and Analytics on Sustainable Energy and Environment (ICICASEE-2023), 2023.**

BEYOND B.TECH: NAVIGATING HIGHER EDUCATION OPPORTUNITIES IN ELECTRICAL ENGINEERING

DR. BIPUL KUMAR TALUKDAR, ASSISTANT PROFESSOR & TPO (I/C)



"Higher education is no longer merely an academic pursuit—it is an investment in expertise, innovation, and lifelong career growth."

Graduating with a B.Tech in Electrical Engineering is a significant milestone, but it is not the destination. As technologies such as Artificial Intelligence (AI), renewable energy, electric mobility, semiconductor manufacturing, robotics, quantum computing, and smart grids reshape industries worldwide, engineers are increasingly expected to possess specialized knowledge that extends beyond an undergraduate degree.

The important question is no longer "Should I pursue higher education?" Rather, it is "What kind of higher education aligns with my career goals?"

WHY CONSIDER HIGHER EDUCATION?

An undergraduate programme equips students with the fundamentals of electrical engineering. However, today's industries seek professionals capable of solving complex interdisciplinary problems involving electronics, computing, automation, sustainability, and data-driven decision-making.

Higher education enables engineers to:

- Develop expertise in emerging technologies.
- Enhance research and analytical skills.
- Improve career prospects and earning potential.
- Qualify for R&D, academic, and leadership positions.
- Build an international professional network.

However, pursuing a postgraduate degree without a clear objective may result in unnecessary expenditure of both time and resources. The choice should be guided by long-term career aspirations rather than social expectations.

BEYOND B.TECH: NAVIGATING HIGHER EDUCATION OPPORTUNITIES IN ELECTRICAL ENGINEERING

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OPPORTUNITIES IN INDIA

India has rapidly emerged as a major destination for advanced engineering education. Institutes such as the IITs, IISc Bengaluru, NITs, IIITs, and several leading universities offer specialized programmes in cutting-edge domains.

Popular higher education pathways include:

M.TECH

Ideal for students interested in technical specialization, research, or teaching.

Emerging specializations include:

- Power Systems
- Power Electronics and Drives
- Control Systems
- Renewable Energy Engineering
- Electric Vehicle Technology
- Smart Grid Technology
- Embedded Systems
- VLSI and Semiconductor Technology
- Artificial Intelligence for Power Systems
- Robotics and Automation

Admission is primarily through GATE, one of India's most competitive engineering examinations.

MS (RESEARCH)

Students inclined towards innovation and research may opt for an MS by Research, which emphasizes original investigation rather than coursework.

MBA

Electrical engineers increasingly pursue MBA programmes to transition into technology management, consulting, operations, finance, product management, or entrepreneurship.

PH.D

A doctoral degree is suitable for those aspiring to careers in research laboratories, academia, policy development, or advanced industrial R&D.

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OPPORTUNITIES ABROAD

Many students aspire to pursue postgraduate studies overseas due to access to world-class laboratories, interdisciplinary research, global collaborations, and exposure to international industries.

Popular destinations include:

- United States
- Germany
- United Kingdom
- Canada
- Australia
- Netherlands
- Sweden
- Singapore
- Japan

Specializations attracting significant global investment include:

- Semiconductor Engineering
- Artificial Intelligence
- Renewable Energy
- Battery Technology
- Robotics
- Autonomous Systems
- Smart Manufacturing
- Quantum Technologies
- Power Electronics
- Cyber-Physical Systems

Several European countries also provide low-cost or tuition-free education in public universities, making quality education accessible to international students.

THE REALITY BEHIND STUDYING ABROAD

Studying abroad is often perceived as a guaranteed pathway to success. The reality is more nuanced.

BEYOND B.TECH: NAVIGATING HIGHER EDUCATION OPPORTUNITIES IN ELECTRICAL ENGINEERING

DR. BIPUL KUMAR TALUKDAR, ASSISTANT PROFESSOR & TPO (I/C)

An overseas degree offers immense opportunities, but success depends on:

- Academic performance
- Research output
- Internship experience
- Communication skills
- Adaptability to a multicultural environment
- Professional networking

Specializations attracting significant global investment include:

- Semiconductor Engineering
- Artificial Intelligence
- Renewable Energy
- Battery Technology
- Robotics
- Autonomous Systems
- Smart Manufacturing
- Quantum Technologies
- Power Electronics
- Cyber-Physical Systems

Several European countries also provide low-cost or tuition-free education in public universities, making quality education accessible to international students.

PREPARING DURING B.TECH

Preparation for higher education should begin much earlier than the final semester.

Students should focus on:

ACADEMIC EXCELLENCE

Maintain a consistently good CGPA while developing a strong understanding of core subjects.

RESEARCH EXPOSURE

Participate in:

- Faculty research projects
- Internships
- Technical paper presentations
- National and international conferences
- Student innovation competitions

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Research experience significantly strengthens applications for both Indian and foreign universities.

TECHNICAL SKILLS

Learn software and tools relevant to your specialization, such as:

- MATLAB/Simulink
- Python
- PSCAD
- ETAP
- LabVIEW
- ANSYS
- COMSOL
- Embedded programming

Hands-on skills often distinguish applicants with similar academic records.

BUILD A STRONG PROFILE

Universities increasingly evaluate applicants holistically.

A competitive profile may include:

- Good academic performance
- Research publications
- Technical projects
- Internships
- Leadership positions
- Community service
- Professional certifications

A well-rounded engineer is often preferred over one with only high examination scores.

COMPETITIVE EXAMINATIONS

Students planning higher education should prepare according to their chosen destination.

FOR INDIA

- GATE
- IIT and IISc admission processes
- Institutional entrance examinations where applicable

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FOR ABROAD

Depending on the university and country:

- IELTS or TOEFL for English proficiency
- GRE (required by some universities, optional or waived by many others)
- Statement of Purpose (SOP)
- Letters of Recommendation (LOR)
- Academic transcripts
- Research proposal (for research programmes)

Preparation for these requirements should ideally begin at least one year before graduation.

CHOOSING THE RIGHT SPECIALIZATION

Students frequently select postgraduate programmes based solely on current trends.

This approach can be risky.

A better strategy is to identify the intersection of:

- Personal interest
- Academic strengths
- Future industrial demand
- Research opportunities

For example, renewable energy, power electronics, semiconductor technology, battery systems, industrial automation, and AI-driven power systems are expected to remain high-growth domains over the coming decade.

Choosing a specialization simply because it is fashionable, without genuine interest, often leads to poor academic and professional outcomes.

FINAL THOUGHTS

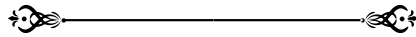
Higher education should not be viewed as an escape from employment or as a race to collect degrees. It should be a deliberate step towards acquiring deeper knowledge, solving real-world problems, and preparing for leadership in an increasingly technology-driven world.

Whether one studies at an IIT, IISc, a reputed foreign university, or another quality institution, success ultimately depends on curiosity, discipline, research aptitude, and the willingness to keep learning.

BEYOND B.TECH: NAVIGATING HIGHER EDUCATION OPPORTUNITIES IN ELECTRICAL ENGINEERING

DR. BIPUL KUMAR TALUKDAR, ASSISTANT PROFESSOR & TPO (I/C)

In the era of Industry 4.0 and beyond, the most valuable qualification is not merely an M.Tech., MS, or Ph.D.—it is the ability to continuously adapt, innovate, and contribute meaningfully to society. For every electrical engineer, higher education is not simply about earning another degree; it is about becoming an engineer capable of shaping the technologies of tomorrow.



LOAD FREQUENCY CONTROL OF THREE-AREA INTERCONNECTED POWER SYSTEM USING FUZZY LOGIC CONTROLLER

SUSMITA PHUKAN,8TH SEMESTER

1. INTRODUCTION

In my research, I tackled the complexity of frequency regulation in multi-area power systems. While conventional PID controllers remain a standard in industry, they often fail to adapt to the non-linearities and parameter uncertainties inherent in interconnected grids. My work focuses on designing an intelligent, adaptive Fuzzy Logic Controller (FLC) framework to replace rigid control methods, ensuring robust performance under dynamic load disturbances.

2. SYSTEM ARCHITECTURE

I modeled a three-area interconnected power system in MATLAB/Simulink, serving as a comprehensive digital twin for frequency analysis. My implementation accounts for the governor-turbine-generator dynamics and the crucial tie-line power flow interconnections that link the three areas.

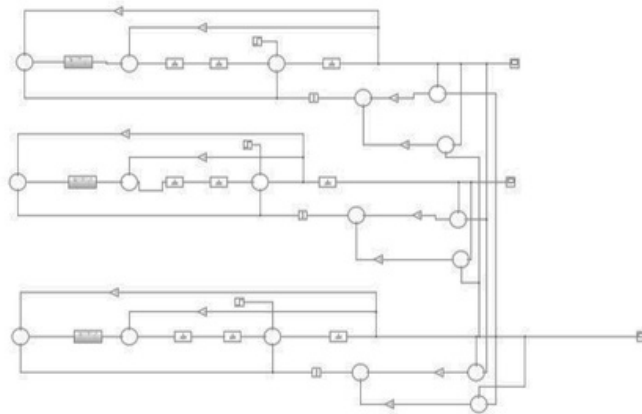


Figure 1: My Simulink block diagram for the three-area interconnected system.

3. FUZZY INFERENCE SYSTEM (FIS) IMPLEMENTATION

To achieve precise frequency regulation across the three-area grid, I designed a modular Fuzzy Logic control framework. My approach was to implement a Mamdani-type FIS that translates grid error states into actionable control signals.

LOAD FREQUENCY CONTROL OF THREE-AREA INTERCONNECTED POWER SYSTEM USING FUZZY LOGIC CONTROLLER

SUSMITA PHUKAN, 8TH SEMESTER

3.1 MY IMPLEMENTATION STRATEGY

- **Input/Output Logic:** I configured the FIS to process two critical inputs—Error (frequency deviation) and Change in Error (rate of frequency drift). My controller maps these to two specific outputs: Control Output (for generation adjustment) and Control Speed (to regulate governor valve response).
- **Modular FIS Design:** I created three distinct FIS files to govern the system. As shown in Fig. 2, I developed the primary logic in FIS 1 to handle Area-1 dynamics. For FIS 2 and FIS 3, I utilized the same rule-base architecture but fine-tuned the internal membership functions to account for the unique tie-line power flow characteristics of their respective areas.



Figure 2: My representative FIS configuration for the control areas.

3.2 WHAT WE ACHIEVED

By modularizing the FIS files, I gained granular control over each area's response. This setup allows the system to behave "intelligently"—applying aggressive correction when frequency drift is rapid, while smoothing out the response as the system nears the 50 Hz nominal setpoint. This intelligent damping is exactly what resulted in the superior settling times observed in my final scope graphs.

LOAD FREQUENCY CONTROL OF THREE-AREA INTERCONNECTED POWER SYSTEM USING FUZZY LOGIC CONTROLLER

SUSMITA PHUKAN, 8TH SEMESTER

4. RESEARCH CONTRIBUTIONS

- **Intelligent Control Design:** I engineered a Mamdani-based FLC that dynamically responds to system disturbances, effectively managing frequency deviations (Δf) and tie-line power flow deviations (ΔP_{tie}).
- **Rule-Based Logic Formulation:** I formulated a rule matrix that intelligently handles non-linearities by mapping input error states to precise control outputs.
- **Dynamic Modeling:** I successfully bridged complex power system dynamics with intelligent decision-making logic using the MATLAB Fuzzy Logic Toolbox.
- **Performance Validation:** I benchmarked the controller under step-load disturbances, achieving faster settling times and significantly reduced transient oscillations compared to conventional PI methods.

5. RESULTS AND PERFORMANCE ANALYSIS

To evaluate the efficacy of the fuzzy logic-based Load Frequency Control (LFC) strategy, I subjected the three-area system to a 0.01 pu step-load disturbance. The simulation results, captured in Figure 3, highlight the system's robust performance:

- **Frequency Deviation (Δf):** As shown in the frequency response scope, Δf peaked at 0.02 Hz initially. My controller successfully dampened this deviation, settling to <0.001 Hz within 4–5 seconds. This performance is well within IEEE standards (± 0.1 Hz) and confirms high regulatory precision.
- **Tie-Line Power (ΔP_{tie}):** The tie-line oscillations damped rapidly toward 0 pu. This indicates that my FIS blocks effectively coordinated power exchange between the three areas, preventing cascading disturbances and ensuring balanced grid operation.
- **Control Signal Dynamics:** As observed in the FIS output scope, the control signals exhibit adaptive scaling—providing rapid increases during the initial disturbance and a gradual, controlled decrease to maintain steady-state stability. For example, during FIS-2 validation with inputs [3, -2], the system generated a balanced Control Output of 5.2 and Control Speed of 3.8, which prevented aggressive, mechanical over-correction of the governor valves.

LOAD FREQUENCY CONTROL OF THREE-AREA INTERCONNECTED POWER SYSTEM USING FUZZY LOGIC CONTROLLER

SUSMITA PHUKAN, 8TH SEMESTER

- **Comparative Efficiency:** The fuzzy-based framework achieved an average settling time of 3.5 seconds with <15% overshoot. This performance metrics significantly outperform the baseline PI controllers, which typically exhibit sluggish recovery and higher transient oscillations.

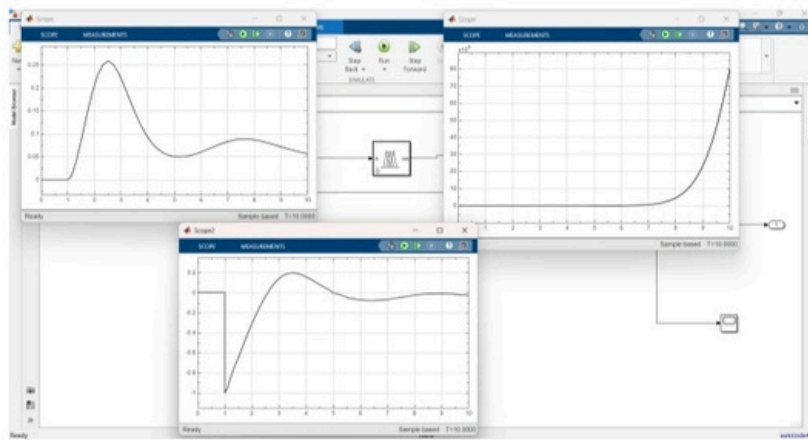


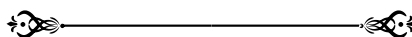
Figure 3: Scope analysis of the fuzzy-based LFC response under 0.01 pu step load.

5.1 ENGINEERING INSIGHTS

Through this simulation, I learned that the effectiveness of the FIS relies heavily on the mapping of linguistic error inputs to mechanical control outputs. The modular design of FIS 1, 2, and 3 allowed me to verify that intelligent, rule-based decision-making is far more effective at handling non-linear system dynamics than static PID tuning. Specifically, the ability to regulate Control Speed alongside Control Output allowed me to achieve aggressive disturbance rejection without risking system instability or turbine wear.

6. CONCLUSION

This research validates that fuzzy logic provides a robust, efficient, and intelligent solution for frequency regulation in interconnected power systems. By automating control decisions based on fuzzy reasoning, I have demonstrated a pathway to more resilient grid management, particularly suitable for modern power systems integrated with volatile renewable energy sources.



THE GEOPOLITICS OF TRANSMISSION: HOW ASSAM CONNECTS SOUTH ASIA'S TRANSNATIONAL SUPER-GRID

CHAMBERLAIN GOGOI, 6TH SEMESTER

Look at a standard political map of India, and the Northeast appears isolated—tethered to the rest of the mainland by the fragile, 22-kilometer-wide Siliguri Corridor, colloquially known as the "Chicken's Neck." For decades, this narrow strip of land has dominated the discourse on the region's connectivity. However, if you swap that political map for an electrical topology map, a completely different reality emerges. On the grid map, the Siliguri Corridor fades into background noise. Instead, you see a robust, interconnected web of ultra-high-voltage transmission lines stretching across international borders. You see massive blocks of power flowing south from the mountains of Bhutan, cutting across the plains of Assam, and feeding straight into the industrial heartlands of Bangladesh.

For the modern electrical engineer, Assam is no longer a geographical periphery. It has become the operational nucleus of South Asia's emerging transnational super-grid. Today, transmission planning in the Northeast is not just about balancing local substation loads; it is an active, vital instrument of India's foreign policy. This is the era of Cross-Border Electricity Trade (CBET), where the Power System Operation Corporation and regional load dispatch centers operate as much on diplomatic alignment as they do on Ohm's Law.



The geopolitical strategy governing Northeast India's energy infrastructure relies on a beautifully complex geographical symmetry. To the north lies Bhutan, a nation blessed with steep glacial rivers and an estimated hydropower potential of over 30,000 MW, of which only a fraction is currently tapped. To the south lies Bangladesh, a rapidly developing, manufacturing-heavy economy with a soaring demand for electricity but severe domestic land constraints that limit large-scale renewable installations. In the middle sits Assam.

THE GEOPOLITICS OF TRANSMISSION: HOW ASSAM CONNECTS SOUTH ASIA'S TRANSNATIONAL SUPER-GRID

CHAMBERLAIN GOGOI, 6TH SEMESTER

During the peak monsoon seasons, Bhutan's run-of-the-river hydroelectric plants generate a massive surplus of clean energy. This power cannot be easily stored, nor can the small domestic grid of Bhutan consume it. Through strategic bilateral and trilateral treaties under India's "Act East" policy, this green energy is stepped up to ultra-high voltages and sent traveling down through the transmission corridors of Assam. From here, it is routed through major international interconnections—such as the Bornagar-Parbotipur line—straight into Bangladesh. For Assam's power engineers, managing this tri-nation balancing act is an immense operational puzzle. Grids across different countries have different peak load hours, distinct consumer profiles, and varying power factor behaviors. Coordinating these massive block transfers while calculating dynamic Total Transfer Capacity (TTC) in real-time requires an incredibly sophisticated understanding of wide-area monitoring systems (WAMS) and phasor measurement units (PMUs) deployed along our regional borders.

International relations might be negotiated by diplomats in air-conditioned rooms, but they are executed by electrical engineers working with high-voltage hardware. Merging independent national grids introduces severe technical vulnerabilities. If a massive power outage or grid fault occurs in a neighboring country's network, it can propagate across international borders instantly, triggering a catastrophic domino effect that could collapse the entire Indian National Grid. To prevent this, engineers rely on specific hardware isolation strategies. The primary shields are High Voltage Direct Current (HVDC) Back-to-Back Terminals. Unlike traditional alternating current (AC) interconnections, a back-to-back HVDC system decouples the two grids. It takes the incoming AC power from one country, rectifies it to DC, and then inverts it back to AC synchronized exactly to the frequency of the receiving grid. Because DC power does not depend on phase angles or frequency locking, it acts as an absolute firewall. If a grid disturbance occurs in Bangladesh, the HVDC terminal blocks the fault from traveling backward into Assam's transmission lines, keeping our regional grid entirely secure.

Furthermore, building new transmission towers across international borders requires complex, politically sensitive land acquisitions. To bypass this bottleneck, engineers are executing massive up-ratings of existing transmission corridors using High-Temperature Low-Sag (HTLS) Conductors. Traditional ACSR (Aluminum Conductor Steel Reinforced) lines sag significantly when carrying heavy currents due to thermal expansion, risking dangerous ground-clearance faults. HTLS conductors utilize advanced carbon-fiber composite cores that can operate at temperatures up to 210°C with minimal physical sagging. By replacing old lines with HTLS technology, Assam's

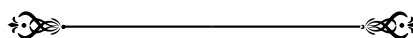
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utilities can double the power transfer capacity over the exact same right-of-way, expanding international trade without digging up a single new plot of land. To maintain voltage stability across these thousands of kilometers of long-distance lines, Flexible AC Transmission Systems (FACTS) devices like Thyristor-Controlled Series Capacitors (TCSC) are heavily utilized. These power electronic systems dynamically alter line impedance, smoothing out voltage fluctuations caused by sudden changes in cross-border power demands.

The current interconnections with Bhutan and Bangladesh are just the opening chapters of a much larger blueprint. The ultimate frontier for South Asian energy geopolitics points further east: toward the ASEAN bloc. Plans are already underway to establish high-voltage transmission links from the Northeast grid through states like Manipur into Tamu, Myanmar. This will mark the first physical power bridge connecting SAARC countries with Southeast Asia. Imagine a future where a solar farm in central India, a hydro plant in Bhutan, and a gas turbine in Assam are all synchronized to power an industrial estate outside of Yangon or Bangkok. This trans-ASEAN connectivity is further supported by heavy infrastructure investments, including strategic partnerships with international development agencies that are actively funding grid modernization and high-voltage distribution projects across Assam. These robust bilateral partnerships ensure that the region's energy highway remains secure, independent, and resilient against external geopolitical monopolies.

What does this mean for the students walking the halls of our Electrical Engineering department today? It means the boundaries of your profession have fundamentally expanded. The modern power engineer graduating from an institute in Assam cannot afford to look at a circuit diagram in isolation. You must understand power system stability equations, machine learning algorithms for predictive grid maintenance, and international energy treaties simultaneously. The systems you will design, maintain, and protect after graduation are no longer confined by state lines; they are weaving the economic and political fabric of an entire subcontinent. As we look toward a decarbonized future, Assam is uniquely positioned to lead. The lines we draw on our blueprints are quite literally illuminating the path toward a unified, green, and interconnected South Asia. The future of global energy diplomacy is being engineered right here, one megawatt at a time.



BACKBONE OF INDIA'S ELECTRICITY SYSTEM

PRINCE PRIYA BORGOHAIN, 6TH SEMESTER

Electricity has become an essential part of modern life. From homes and schools to hospitals, industries, transportation, and communication systems, almost every sector depends on a continuous supply of electrical power. Although switching on a light or charging a mobile phone seems simple, it is made possible by a vast and highly interconnected electricity network operating behind the scenes.

India, the world's third-largest producer and consumer of electricity, generates more than 2,000 terawatt-hours (TWh) of electricity every year to meet the needs of over 1.4 billion people. Such a massive demand can only be met through a strong generation system supported by an efficient transmission network. Together, these two components form the backbone of India's electricity system and play a vital role in ensuring reliable power for the country's economic and social development.

THE GENERATION BACKBONE: COAL'S STEADY ROLE

India's power sector has changed significantly over the past decade with the rapid expansion of renewable energy. Even so, coal continues to remain the primary source of electricity generation. At present, coal-fired thermal power plants contribute nearly 74–75% of the country's total electricity generation, making them the main source of dependable base-load power. Unlike renewable sources, these plants can operate continuously and are capable of supplying electricity throughout the day, regardless of weather conditions.

Renewable energy sources such as solar and wind have grown rapidly because they are cleaner and environmentally friendly. However, their output depends on the availability of sunlight and wind, making them intermittent by nature. As a result, they cannot always meet electricity demand on their own. To maintain the balance between generation and consumption, thermal power stations continue to provide the stability required by the grid.

India has already installed more than 230 GW of renewable energy capacity, including large hydroelectric projects, and this capacity is expected to increase steadily in the coming years. Nevertheless, conventional generation remains necessary to support renewable energy until large-scale energy storage technologies become more widespread. In addition, India possesses the fifth-largest coal reserves in the world, allowing the country to rely on domestic fuel resources and reduce exposure to fluctuations in international fuel prices. Therefore, while renewable energy is expanding rapidly, coal continues to play an important role in maintaining the reliability of India's electricity supply.

BACKBONE OF INDIA'S ELECTRICITY SYSTEM

PRINCE PRIYA BORGOHAIN, 6TH SEMESTER

THE TRANSMISSION BACKBONE: THE NATIONAL GRID

Generating electricity is only one part of the power system. The electricity produced at power stations must be transported safely and efficiently to consumers located across different regions of the country. Since power plants are often situated far from major cities and industrial centres, electricity has to travel hundreds or even thousands of kilometres through high-voltage transmission lines before reaching distribution networks.

This responsibility is carried out by the National Grid, which forms the transmission backbone of India's electricity system. The National Grid connects different regional power systems into one synchronized network, allowing electricity to flow across state boundaries whenever required. This interconnected structure improves the overall reliability of the power system by enabling surplus electricity from one region to be supplied to another experiencing higher demand.

THE FUTURE: TRANSITION TOWARDS A DUAL BACKBONE

India's electricity sector is currently undergoing one of its most important transitions. With the national target of achieving 500 GW of non-fossil fuel capacity by 2030, both electricity generation and transmission infrastructure are being expanded at an unprecedented pace. The focus is no longer limited to increasing power generation alone. Equal importance is now being given to developing a smarter and more flexible grid that can accommodate large amounts of renewable energy without compromising system stability.

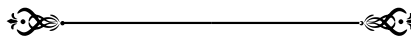
Several initiatives are supporting this transition. Projects such as the Green Energy Corridors are strengthening transmission networks to connect renewable energy-rich regions with demand centres. At the same time, technologies including battery energy storage systems (BESS), pumped hydro energy storage, advanced forecasting techniques, real-time grid monitoring, and smart grid automation are improving the flexibility and reliability of the power system.

BACKBONE OF INDIA'S ELECTRICITY SYSTEM

PRINCE PRIYA BORGOHAIN,6TH SEMESTER

Large renewable energy projects, including the 2.7 GW Bhadla Solar Park in Rajasthan, demonstrate India's commitment to clean energy. Wind power installations, new nuclear power projects, and modern transmission corridors are also contributing to a more diversified electricity mix. Despite these developments, coal-fired power plants are expected to continue providing dependable base-load generation during the transition period, ensuring that electricity demand is met even when renewable generation fluctuates.

Looking ahead, India's electricity system is expected to evolve into a dual backbone in which conventional and renewable energy sources complement one another instead of competing. Conventional power plants will continue to provide stability and reliability, while renewable energy will steadily increase its contribution to electricity generation. Supported by advanced transmission infrastructure, energy storage technologies, and intelligent grid management, this balanced approach will strengthen India's energy security and help the country move towards a cleaner, more sustainable, and resilient power system.



QUANTUM COMPUTING AND ITS POTENTIAL IMPACT ON ELECTRICAL ENGINEERING

NILAY DEEP BHARADWAJ, 6TH SEMESTER

Each generation has its own innovation which impacts the lives of humans in a way or another. In our times, the advent of Quantum Computing is one such technology revolution that can prove to be among the most revolutionary of the 21st century. While it is still in its infancy, it holds promise in solving complex problems which cannot be solved even by conventional computers.

Quantum computing is one of the most exciting technological advancements of the modern era. By harnessing the principles of quantum mechanics, it has the potential to solve highly complex problems that are impossible or extremely time-consuming for even the fastest classical computers. Quantum Computing in Electrical Engineering has the ability to revolutionize the creation of new hardware as well as problem-solving techniques for complex engineering problems. While classical computers operate on the basis of bits that can take either a 0 or 1 state, quantum computers operate with the help of qubits that are in several states at once.

It is the special characteristics of qubits that provide quantum computers with the capability of solving some problems that can be extremely hard or even impossible to solve using classical computers. From the standpoint of Electrical Engineering, there are a lot of interesting opportunities related to solving complex optimization problems and carrying out simulations.

- **Circuit Design and Simulation** - One of the most promising directions of quantum computing usage in Electrical Engineering includes circuit design and simulation. Designing an electronic circuit may require the analysis of millions of different options which makes it very time-consuming and computationally costly. The main advantage of quantum computers compared to the conventional ones is that quantum computers are capable of simulating electronic components better and faster.
- **Material Science** - With quantum computing, material science could be revolutionized in such a way that simulations can be done of material behaviors down to an atomic level. This would enable the creation of more efficient and effective materials with higher conductance and performance properties.
- **Cryptography and Security** - Quantum computing has immense possibilities for cryptography and security in the field of Electrical Engineering. On one hand, it is capable of breaking down most current encryption techniques; on the other hand, it also allows quantum technology like Quantum Key Distribution (QKD). QKD makes communication extremely secure, and will assist electrical engineers in building safe smart grids and communication network
- **Power Grid Optimization** - There are various ways in which quantum computing can be applied to optimize the operations of the power grid. This technology would be able to perform more efficiently when analyzing data related to power systems than traditional computers. With this, electrical engineers would be able to create better load balancing, minimize transmission losses, and optimize energy distribution.

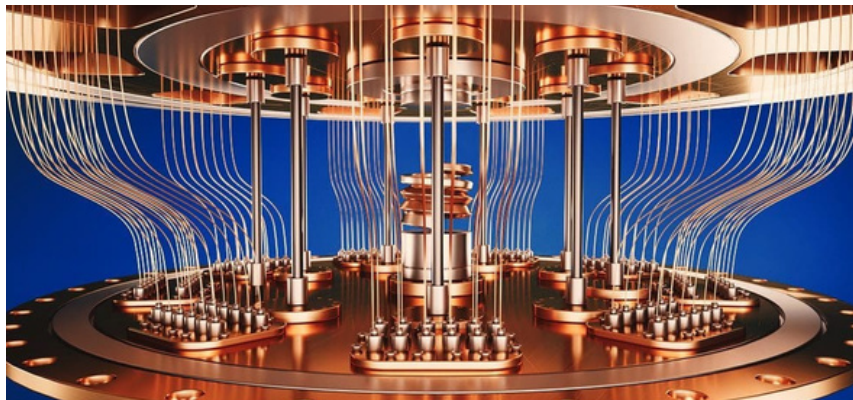
QUANTUM COMPUTING AND ITS POTENTIAL IMPACT ON ELECTRICAL ENGINEERING

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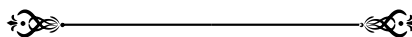
NILAY DEEP BHARADWAJ, 6TH SEMESTER

Smart grid and renewable energy - Another possible area where quantum computing can be used in electrical engineering is the construction of smart grids as well as incorporation of renewable energy sources into them. The contemporary power systems need to maintain a continuous balance between production and consumption of electricity with regard to the variable sources of power like solar and wind energy. It implies that complicated optimization processes take place continuously. With the help of quantum computing, huge amounts of data from the grid can be analyzed in a short period of time allowing for an accurate forecast of demand and fast detection of faults.



Quantum Computing for Electrical Engineers goes beyond being an upcoming technology; it is a new dimension in which research and innovation must take place. The engineers of the future need to acquire skills that integrate electrical engineering, electronics, computer sciences, mathematics, and quantum physics into one. As industries develop technologies in the quantum world, there will be a growing need for individuals who are skilled in quantum technology to develop advanced power systems, communications infrastructure, semiconductor devices, and intelligent automation systems.

India is witnessing substantial advancements in the area of quantum technology via its National Quantum Mission, which was initiated in 2023. The primary goal of this mission includes the development of home-grown quantum computers, secure quantum communications, quantum sensors, and talent pool. Some major educational institutions and research firms such as IITs, IISc, DRDO, ISRO, and C-DAC are currently working towards the advancement of quantum technology. With the development of the quantum field, many opportunities will be available for electrical engineers in fields like smart grids, secure communication, semiconductors, and advanced computing.



ENERGY TRANSITION TOWARDS ELECTRIC VEHICLE TECHNOLOGY

SWARAJ MAZINDER BARUA, 6TH SEMESTER

The global shift towards clean energy has made Electric Vehicle (EV) technology a key driver of sustainable transportation. As concerns over climate change, air pollution, and fossil fuel depletion continue to grow, EVs are emerging as an efficient and environmentally friendly alternative to conventional internal combustion engine (ICE) vehicles.

Electric vehicles use electric motors powered by rechargeable batteries, offering higher energy efficiency, lower maintenance costs, and zero tailpipe emissions in fully electric models. As renewable energy sources become more integrated into power systems, EVs will play a vital role in reducing the transportation sector's carbon footprint.

The rapid growth of EVs is largely driven by advancements in battery technology. Modern lithium-ion batteries provide higher energy density, longer life, and faster charging than earlier designs. Researchers are also developing solid-state batteries, which promise greater safety, quicker charging, and increased driving range.

Charging infrastructure is evolving alongside vehicle technology. Fast-charging stations, smart charging systems, and emerging wireless charging solutions are making EVs more practical for everyday use. At the same time, innovations in power electronics, battery management systems, and regenerative braking continue to improve vehicle efficiency and performance.



Charging infrastructure is evolving alongside vehicle technology. Fast-charging stations, smart charging systems, and emerging wireless charging solutions are making EVs more practical for everyday use. At the same time, innovations in power electronics, battery management systems, and regenerative braking continue to improve vehicle efficiency and performance.

Modern EVs are also becoming smarter. Artificial Intelligence (AI), Advanced Driver Assistance Systems (ADAS), and connected technologies enable intelligent navigation, predictive maintenance, and enhanced safety. Another promising innovation is Vehicle-to-Grid (V2G) technology, which allows EVs to exchange electricity with the power grid, supporting renewable energy integration and improving grid stability.

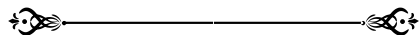
Despite impressive progress, challenges such as limited charging infrastructure, high battery costs, and battery recycling remain. Continued research, supportive government policies, and industrial innovation are essential to overcome these barriers.

ENERGY TRANSITION TOWARDS ELECTRIC VEHICLE TECHNOLOGY

SWARAJ MAZINDER BARUA, 6TH SEMESTER

For Electrical Engineering students, the EV revolution offers exciting opportunities in power electronics, electrical machines, battery technology, smart grids, renewable energy, and embedded systems. As transportation becomes increasingly electrified, electrical engineers will play a crucial role in designing the technologies that power a cleaner and more sustainable future.

Electric vehicle technology is not just transforming automobiles—it is reshaping the entire energy ecosystem. The transition to electric mobility marks a significant step towards a greener, smarter, and more sustainable world.



THE UNBOUND CURRENT: THE REALITY OF WIRELESS POWER TRANSMISSION

AKASH JYOTI DAS, 6TH SEMESTER

"Every great technological revolution begins by challenging something we once believed was permanent."

For centuries, roads carried people, paper carried information, and wires carried electricity. Today, information flows invisibly through the air. We stream movies and connect billions of devices without a single cable. It naturally raises a question: if we no longer need wires to send information, will we someday stop needing wires to send electricity?

At first glance, this sounds like science fiction. Your phone charges automatically while still in your pocket. An electric car replenishes its battery just by parking over a marked space. Medical implants operate for years without surgery to replace batteries. Drones stay airborne indefinitely because they receive power from the ground.

None of these ideas belong entirely to the future. They are already being tested, or quietly becoming part of daily life. The real question is not whether wireless power is possible, but whether physics will let it become the next revolution in electrical engineering, not as a replacement for the wire, but as a way of removing it exactly where it stops making sense.

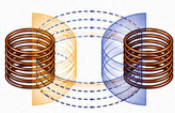
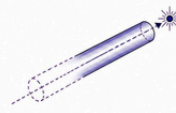
A DREAM OVER A CENTURY OLD

The idea of transmitting electricity without wires is older than most people realize. In the early 1900s, Nikola Tesla imagined electricity travelling through the air to power entire cities without transmission lines. His ambitions were limited by the technology of his era. But modern breakthroughs in high-frequency power electronics and magnetic resonance are finally making that vision commercially viable. We are no longer debating if energy can travel without a conductor. We are engineering the distances and efficiencies required to make the wire an optional part of the system.

HOW ELECTRICITY TRAVELS THROUGH THIN AIR

The Three Pillars of Wireless Transfer

Three distinct physical principles dictate the spectrum of wireless power.

INDUCTIVE COUPLING	RESONANT TRANSFER	MICROWAVE & LASER
		
Range: Millimetres Alignment: Flush/High Use: Qi Phone Chargers	Range: 50–200 mm Freq: 20–85 kHz Power: 3.3 kW to 800+ kW Efficiency: Up to 90% Use: EVs, Robotics (WiTricity, KAIST, INTIS)	Range: Kilometres Method: Direct Line-of-Sight Use: Satellites, High-Altitude Drones, Space-Solar

Inductive Coupling: It is the technology in most wireless phone chargers. Alternating current in a transmitting coil creates a changing magnetic field. A nearby receiving coil captures this field and converts it back into electricity. It is simple and reliable, but effective only across a few millimetres. That is why your phone must sit almost flush against the pad.

THE UNBOUND CURRENT: THE REALITY OF WIRELESS POWER TRANSMISSION

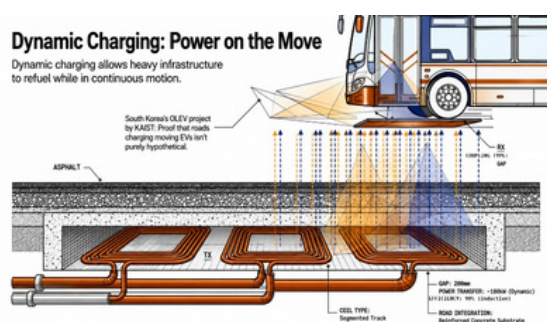
AKASH JYOTI DAS, 6TH SEMESTER

Resonant Wireless Power: It tunes both coils to the same frequency, allowing transfer over much greater distances. The field gained momentum after a landmark 2006 MIT experiment demonstrated mid-range transfer using magnetic resonance. Real systems built on this principle, developed by WiTricity, KAIST, and INTIS, now operate at 20 to 85 kHz, delivering anywhere from 3.3 kW to over 800 kW, with efficiencies reaching up to 90% across air gaps of 50 to 200 mm. This frequency tuning lets the field bypass nearby non-resonant objects, which is exactly what makes it viable in crowded industrial settings, not just phone charging, but moving machinery too.

Microwave and Laser Power Transfer: It converts electricity into microwaves or laser beams for much longer distances. Specialized receivers then convert the beam back into electricity. Researchers are studying this for satellites, high-altitude drones, and remote sensing, where it could turn a drone with limited flight time into a permanently airborne telecommunication hub. One day, even solar power collected in space may be beamed wirelessly back to Earth.

WHERE IT'S ALREADY WORKING

Wireless power is not just a future concept. It is already solving real problems across very different scales. Pacemakers avoid repeated battery-replacement surgeries, cutting down surgical risk and long-term patient cost. Automated warehouse robots and subsea sensors run continuously without stopping to recharge, which removes the need for maintenance-heavy connectors in corrosive or sealed environments.



In public transit, South Korea's OLEV project, built by KAIST, has already deployed buses that charge dynamically from coils embedded beneath the road as they drive. This distinction matters. Static charging, where a vehicle simply parks over a pad, still leaves range anxiety unsolved. Dynamic charging lets fleets run continuously while carrying smaller, lighter batteries, and that changes the basic economics of a transit system

THE UNBOUND CURRENT: THE REALITY OF WIRELESS POWER TRANSMISSION

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CAN WIRES REALLY DISAPPEAR?

Not entirely. As the distance between transmitter and receiver increases, efficiency drops. Energy spreads outward according to the inverse-square law, so only part of it reaches the target. Even everyday Qi phone chargers, which hit roughly 70 to 80% efficiency under ideal conditions, can fall to 40 to 60% with slight misalignment. This is a physics constraint, not a manufacturing flaw.

Add to this the heat generated every time electricity converts to a magnetic field and back, plus strict electromagnetic safety limits and the risk of interfering with nearby communication systems. These are not engineering inconveniences waiting to be optimized away. They come from the fundamental laws of electromagnetics.

This is why high-voltage transmission lines remain irreplaceable for long-distance transmission. They move vast amounts of power across hundreds of kilometres with unmatched efficiency. Wireless power is not trying to replace that backbone. It works best as a surgical tool, used wherever a physical tether creates unnecessary friction, such as in moving parts, sealed medical implants, or dynamic transit routes.

BUILDING WISELY

Wireless power can improve safety, cut maintenance, and enable technologies a plug simply could not. But every deployment should be evaluated as a precision tool, not a default upgrade. The real question is not "can we make this wireless?" but "does removing the tether outweigh the efficiency lost in the air gap?" Knowing where innovation genuinely improves lives, versus where it is just possible, is the judgment every generation of engineers has to develop.

FINAL THOUGHTS

Will wires disappear completely? Probably not. Copper conductors remain among the most efficient ways to move large amounts of electrical energy over long distances, and they will stay vital for decades to come. The future is not a choice between wires and wireless. It is a hybrid system: copper for the backbone, resonant coupling and microwave beaming for the last meter and the moving parts.

Just as Wi-Fi transformed communication without eliminating fibre-optic cables, wireless power will reshape how we think about electricity without making transmission lines obsolete. Perhaps the next revolution in electrical engineering will not be the disappearance of wires, but the freedom to use them only where they are needed.

THE UNBOUND CURRENT: THE REALITY OF WIRELESS POWER TRANSMISSION

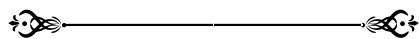
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THE NUMBERS BEHIND THE TECHNOLOGY

Technology	Range/Air Gap	Power/Efficiency	Key Applications	Developers
Inductive Coupling	A few millimetres	70 to 80% ideal; 40 to 60% with misalignment	Phone/earbud chargers, toothbrushes, RFID, pacemakers	Qi standard
Resonant Wireless Power	50 to 200 mm	3.3 kW to 800+ kW; up to 90%	EVs, industrial robots, warehouses, buses	WiTricity, KAIST (OLEV), INTIS
Microwave / Laser Transfer	Long range (m to km)	Data limited	Satellites, high-altitude drones, space-based solar	Research stage

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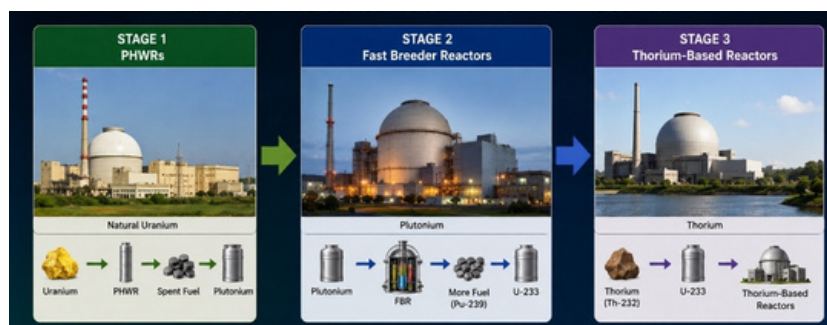
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INDIA'S THREE-STAGE NUCLEAR POWER PROGRAMME

MANAS PRATIM CHOUDHURY, 4TH SEMESTER

India holds limited uranium reserves but one of the largest thorium reserves in the world. To make the most of these resources, the Department of Atomic Energy designed a three-stage nuclear power programme built on a closed nuclear fuel cycle. The goal is to progressively multiply domestic fissile resources and secure long-term energy independence.



STAGE 1: PRESSURISED HEAVY WATER REACTORS (PHWRs)

- Natural uranium is used as fuel in PHWRs to generate power.
- The spent fuel from these reactors produces plutonium, which becomes the primary input for the next stage.

STAGE 2: FAST BREEDER REACTORS (FBRs)

- The plutonium obtained from Stage 1 is used as fuel in Fast Breeder Reactors, which generate more fuel than they consume.
- The PFBR at Kalpakkam marks India's entry into this stage.
- These reactors will be used to breed Uranium-233 from thorium, laying the groundwork for Stage 3.

STAGE 3: THORIUM-BASED REACTORS

- This stage will harness India's vast thorium reserves at scale, using the Uranium-233 bred in Stage 2 as fuel.
- Thorium is considered a practically vast energy source and this stage holds the key to India's long-term energy security.

Each stage feeds into the next, making India's nuclear programme one of the most forward-looking energy strategies in the world.

INDIA'S THREE-STAGE NUCLEAR POWER PROGRAMME

MANAS PRATIM CHOUDHURY, 4TH SEMESTER

PFBR: AN OVERVIEW

The Prototype Fast Breeder Reactor (PFBR) represents decades of indigenous research, design, and engineering. Its technology was developed by the Indira Gandhi Centre for Atomic Research (IGCAR), an R&D centre under the Department of Atomic Energy.

FUEL AND DESIGN

- Unlike conventional thermal reactors, the PFBR uses Uranium-Plutonium Mixed Oxide (MOX) fuel.
- The fissile material used is recovered from the reprocessing of spent fuel from Pressurised Heavy Water Reactors, closing the loop on Stage 1.

BREEDS MORE THAN IT BURNS

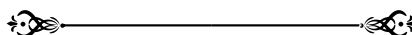
- The core of the PFBR is surrounded by a blanket of Uranium-238.
- Fast neutrons convert this fertile material into fissile Plutonium-239, enabling the reactor to produce more fuel than it consumes.

BRIDGE TO STAGE 3

- The reactor is designed to eventually use Thorium-232 in the blanket.
- Through transmutation, Thorium-232 will be converted into Uranium-233, the fuel that will power India's third stage of nuclear energy based on thorium.

CLOSED FUEL CYCLE

- The spent fuel generated by the PFBR will be reprocessed and recycled back into the reactor.
- This closes the second-stage fuel cycle and paves the way for large-scale use of India's abundant thorium reserves in Stage 3.



বিভাগীয় সংগীত

উত্তৰ-পূবৰ ৰেঙণি তুমি ,
উনৈছশ ষাঠিৰে পৰা জিলিকা তুমি
এখনি ৰঙীন আকাশ তুমি
তোমাৰ বুকুৰে এখনি বৈদ্যুতিক পথাৰ,
আৰম্ভ হৈছিল উনৈছশ এশাঠিৰে পৰা
প্ৰযুক্তিবিদ্যাৰে অসম পোহৰাই তোলাৰ জোৱাৰ ।
জিলিকি বৈছে ভোগদৈৰ দাঁতি !
জ্বলি উঠিছে কত প্ৰদীপ্ত বন্তি ,
বৈদ্যুতিকতা ৰং সানি হয়
বৈদ্যুতিক অভিযন্তা আমি ।
আহা আমি খোজ দিও
প্ৰগতিৰ পথত অগ্ৰসৰৰ দিশে ,
প্ৰযুক্তিযুক্তিবিদ্যাৰে চৌপাশ উজ্জ্বল কৰাৰ
উদ্দেশ্যে ।

কথা :
বৰষা ৰাণী বৰা

সুৰ:
অৰ্ণৱ কল্লোল বৰা
নীলাভ নয়ন ফুকন