ZEAL INSTITUTES

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NARHE I PUNE I INDIA

*Re-defining Exellence*

# ELECTRONICS AND TELECOMMUNICATION ENGINEERING

# SPECTRUM

## 2K23-24

## Institute:

# Vision

To become a premier institute in technical education by imparting vibrant knowledge and skill based quality education with ethical values to cater the industrial and societal needs.

# Mission

1. To provide comprehensive technical education through academic excellence.

2. To give industrial exposure to the students by industry- institute interaction.

3. To inculcate Technical competence, spirit of enquiry, teamwork and entrepreneurship.

4. To enhance ethical, societal, industrial concerns and life long learning skills.

## Department:

# Vision

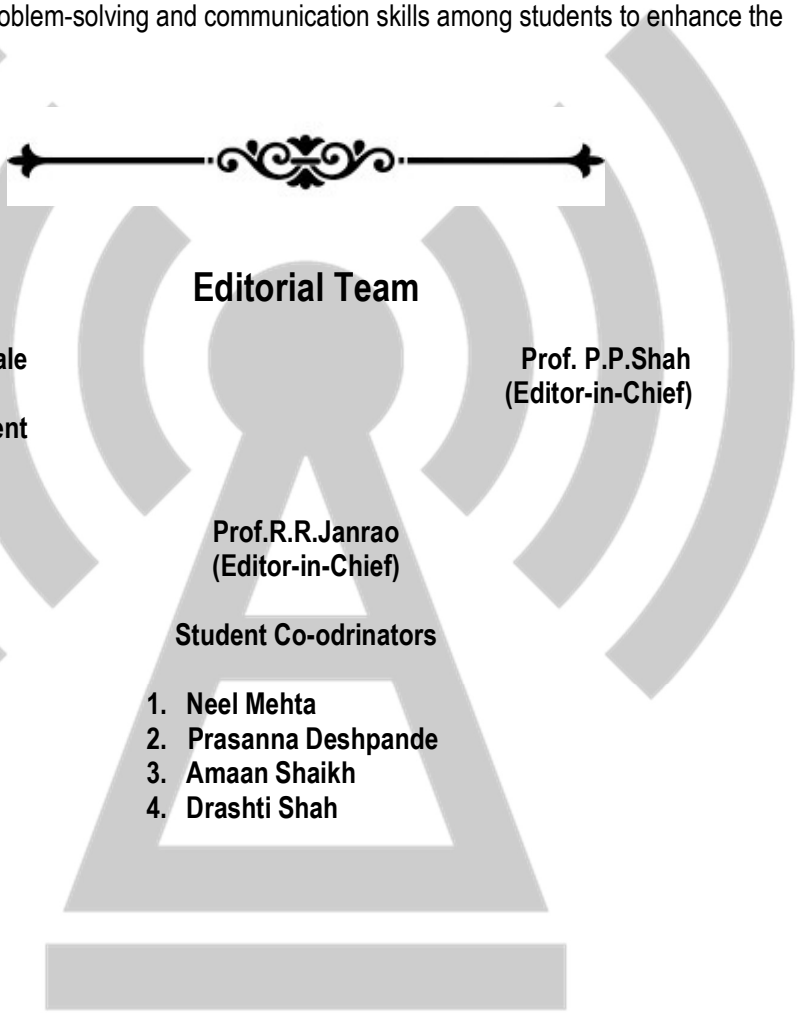
"To develop ethically sound and competent Electronics & Telecommunication Engineers by imparting quality education to serve industry and societal needs."

# Mission

**M1:** Impart technical skills and competencies with professional ethics through comprehensive teaching-learning process to meet society and industry needs

**M2:** To enhance technical skills of students through industry institute interactions, quality education and lifelong learning to excel in multidisciplinary work environments.

**M3:** Cultivate creative thinking, problem-solving and communication skills among students to enhance the spirit of entrepreneurship.



## Editorial Team

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**E&TC Department**

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# Founder Director's Message

I believe that diploma education provides hands on experience to students. Therefore as an entrepreneur, I insisted my three sons to take admission in polytechnic before going to higher education in mechanical engineering.

At zeal polytechnic, we are committed to creating an ambience for nurturing innovation, creativity and excellence in our students. We aim to prepare young engineer entrepreneurs and managers. They will have the competence and confidence to face all challenges. It is possible only when we impart high quality technical and managerial education coupled with appropriate training and wide exposure to the state of art practices.

This newsletter lays emphasis on all round personality development and also on inculcating human values and professional ethics. It helps our students become more human and socially responsible beings to lead a meaningful life. I wish a very knowledgeable, healthy and prosperous life to all.

**Hon. Shri. S. M. Katkar**
**Founder Director,**
**Zeal Education Society, Pune.**

# Principal's Message

We provide best platforms to budding engineers to acquire technical knowledge, motor skills and soft skills which are utmost demands of the industry. Uniqueness of our institute is a caring, nurturing culture that recognizes the various aspects of each student and encourages them to bloom to their fullest with confidence.

We are also committed to very good quality of teaching-learning process with having maintained high grade discipline among the staff and students and to achieve sky-scraping point superiority in academic by maintaining a conductive atmosphere for studies, state-of art laboratories communication center and digital library. MOUs have been signed with reputed organization to impart cutting edge technologies through extensive courses.

In another view, we aim at development of our student at different levels by the proper encouragement, guidance, support and generation of in-house recourses for sports, cultural, yoga, meditation etc followed by giving them a confidence to feel free at home.

These efforts have resulted in more placements and we are keen to argument it further. We are quite self-assured for the molding and nurturing of our students as a young, bright, dynamic, talented & professional technocrats and a responsible gentle citizen by raising the our actions to at high quality technical education.

**Prof. A.A.TAMBOLI**

**Principal, Zeal Polytechnic**
**Zeal Education Society, Pune.**

# Head of Department (H.O.D.) Message

The Department of Electronics & Telecommunication has a strong team of faculty members who grace the department with their extensive teaching experience and industrial exposure to the department. The department offers excellent facilities in terms of modern equipment and instruments to the students.

Faculty members pay special attention to all the students for their curricular and co- curricular development. The department aims providing excellent theoretical and practical knowledge which helps the students in the academic growth.

The department organises various industrial visits offer practical exposure of the industry to the students. To add a feather to our hat, MSBTE has awarded an 'Excellent' grade during external monitoring.

**Prof. S.N.NAVALE**
**H.O.D**
**E&TC Department**

# 5G Communication Systems


**Introduction:** 5G is the current global standard for mobile communication and wireless networks. It is designed to meet the demands of a hyper-connected world with numerous devices and applications that require higher data rates, lower latency, and improved reliability

## Key Features of 5G:

1. **Enhanced Data Rates**: 5G networks can deliver peak download speeds of up to 20 Gbps and upload speeds of 10 Gbps, significantly higher than 4G.
2. **Ultra-Low Latency**: Latency is reduced to around 1 millisecond, which is crucial for real-time applications like autonomous vehicles, industrial automation, and augmented reality (AR).
3. **Massive Device Connectivity**: 5G is designed to handle up to 1 million devices per square kilometer, which is crucial for the growing Internet of Things (IoT).
4. **Network Slicing**: 5G allows for the creation of multiple virtual networks (slices), each optimized for specific use cases, such as IoT, industrial applications, or high-speed media streaming.
5. **Higher Reliability**: 5G offers higher reliability for critical applications, such as remote surgery, smart grids, and emergency services.
6. **Energy Efficiency**: 5G aims to be more energy-efficient than previous generations, which is essential to reduce the carbon footprint and meet sustainability goals.


## Beyond 5G (B5G):

Beyond 5G is a term used to describe the research, development, and technologies that extend the capabilities of 5G and push towards the 6G era. B5G focuses on:

1. **Enhanced AI and Automation**: Integration of Artificial Intelligence (AI) to optimize network management, predict failures, and ensure self-healing networks.
2. **Terahertz Communication**: Moving beyond millimeter waves to even higher frequencies (e.g., terahertz) to support ultra-fast data transfer and massive bandwidth.
3. **Advanced Edge Computing**: Placing computing resources closer to users and devices to minimize latency and support real-time applications like autonomous vehicles, smart cities, and AR/VR.
4. **Quantum Communications**: Exploring quantum technologies to offer secure communication channels with quantum encryption for ultra-secure data transfer.
5. **Integration of Satellite Networks**: Bringing satellite networks into the fold to provide global, seamless connectivity, especially in rural and remote areas.

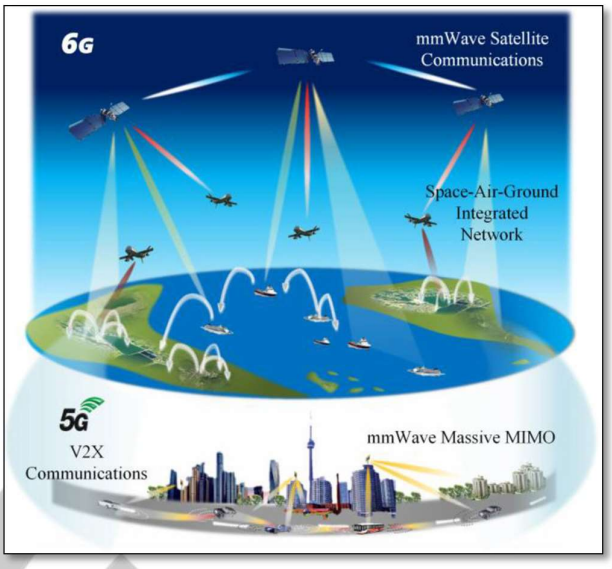

## 6G: The Future of Communication


6G is the sixth generation of mobile networks, expected to emerge around 2030, and will surpass 5G's capabilities. Its potential includes:

1. **Exabyte-Level Data Rates**: 6G networks could provide speeds up to 1 Tbps (terabit per second) or higher, enabling innovations like ultra-HD video, holography, and instantaneous content sharing.
2. **Ultralow Latency (Sub-Millisecond)**: 6G aims to reduce latency even further, potentially enabling real-time, lifelike experiences for augmented and virtual reality (AR/VR) and immersive experiences like holograms.
3. **Intelligent Networks with AI**: Networks will become more intelligent, using advanced AI to provide dynamic, adaptable communication for users, improving energy efficiency and automating network management.
4. **Hyperconnectivity and Ubiquitous IoT**: 6G will connect billions of devices in a truly ubiquitous way, including wearable devices, autonomous systems, smart cities, and virtual worlds.
5. **Integration of Biological and Digital Worlds**: 6G is expected to blur the lines between the biological and digital worlds, supporting brain-machine interfaces, neural networks, and human augmentation.
6. **Holographic Communication**: 6G might make holographic video calls a reality, offering immersive 3D communication and collaboration.
7. **Global Coverage**: 6G will aim for truly global connectivity, combining terrestrial, satellite, and other communication systems to deliver seamless coverage everywhere.

## Technologies Enabling 6G:


1. **Terahertz Waves**: 6G will operate in the terahertz spectrum (0.1–10 THz) to achieve unprecedented data speeds and capacity.
2. **AI-Driven Networks**: AI will be deeply integrated into 6G networks for tasks like real-time optimization, fault prediction, and self-healing, as well as enabling new applications such as autonomous systems and machine-to-machine (M2M) communications.




3. **Advanced Antennas and Smart Surfaces**: 6G will use advanced antenna technologies, including large-scale intelligent surfaces, to direct signals and improve efficiency.
4. **Quantum Networks**: 6G may rely on quantum computing and quantum cryptography to ensure ultra-secure communication, enabling new possibilities in secure communication.
5. **Ultra-Massive MIMO**: Using massive antenna arrays, ultra-dense networks, and spatial multiplexing, 6G will provide the necessary capacity for high-demand applications.

## Conclusion

5G has set a new benchmark for mobile connectivity, offering improved data rates, low latency, and efficient network management. However, the future lies in **Beyond 5G** and **6G** technologies, which promise to revolutionize communication with advances in AI, quantum computing, and terahertz waves. These systems will enable new applications like holographic communication, immersive AR/VR, autonomous vehicles, and intelligent networks, paving the way for a hyper-connected world.

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# Internet of Things (IoT)


The **Internet of Things (IoT)** refers to the network of physical objects, devices, vehicles, buildings, and other items embedded with sensors, software, and other technologies that enable them to collect, exchange, and process data over the internet. The goal of IoT is to create smarter environments by enabling objects to interact with each other, make decisions autonomously, and improve efficiency across various domains.

IoT is transforming industries, improving everyday life, and enabling new capabilities in fields such as healthcare, manufacturing, transportation, agriculture, and urban management.


## Key Components of IoT:

1. **Devices (Things)**:

    - Physical objects such as sensors, actuators, appliances, vehicles, wearables, and smart home devices.
    - These devices are often equipped with sensors to collect data (e.g., temperature, humidity, location, etc.) and can include actuators that perform actions based on received commands (e.g., turning off a light or adjusting a thermostat).

2. **Connectivity**:

   - **IoT devices rely on various types of connectivity to transmit data. This can include:**

     - **Wi-Fi**: Common in smart homes and consumer devices.
     - **Bluetooth**: Often used for short-range connections (e.g., fitness trackers, smartwatches).
     - **Cellular networks (e.g., 4G, 5G)**: Used for mobile IoT devices requiring long-range communication.
     - **Low Power Wide Area Networks (LPWAN)**: Technologies like LoRaWAN and Sigfox are used for remote IoT devices that require low power consumption and long-range communication.
     - **Zigbee/Z-Wave**: Common in smart home devices for short-range, low-power communication.

3. **Data Processing**:

   - Once data is collected from IoT devices, it needs to be processed. This can happen locally (on the device or at the edge of the network, i.e., **Edge Computing**) or in the cloud, where advanced algorithms, AI, and machine learning can analyze large amounts of data to gain insights and make predictions.

4. **Data Storage**:

   - The massive amounts of data generated by IoT devices need to be stored. Cloud storage systems are widely used to store IoT data due to their scalability, although edge storage can also be used for quick local access.

5. **Actuators and Responses**:

   - IoT systems often generate responses based on the data they process. For example, a smart thermostat may adjust the temperature based on the data from a temperature sensor. This can be an automatic response or triggered by a human user.

## Types of IoT Applications:


1. **Consumer IoT (CIoT)**:

   - **Smart Homes**: Devices like smart thermostats (e.g., Nest), smart lighting (e.g., Philips Hue), smart security systems, and voice assistants (e.g., Amazon Alexa, Google Assistant) enhance convenience, comfort, and energy efficiency.
   - **Wearables**: Fitness trackers (e.g., Fitbit, Apple Watch), health monitoring devices (e.g., continuous glucose monitors), and smart clothing are all examples of IoT-enabled devices.
   - **Smart Appliances**: Connected kitchen appliances, refrigerators, washing machines, and home assistants can improve household management and energy use.

2. **Industrial IoT (IIoT)**:

   - **Smart Manufacturing**: Sensors embedded in machines help monitor performance, predict maintenance, and optimize manufacturing processes. This is often referred to as **Industry 4.0**, which integrates IoT with automation, big data, and AI to improve manufacturing efficiency.
   - **Predictive Maintenance**: IoT sensors can detect wear and tear on machinery before failure occurs, reducing downtime and maintenance costs.
   - **Supply Chain and Inventory Management**: IoT enables real-time tracking of goods, assets, and inventory, improving logistics and reducing the likelihood of overstocking or stockouts.

3. **Healthcare IoT (IoMT)**:

   - **Remote Patient Monitoring**: Devices such as wearable health trackers, glucose monitors, and blood pressure cuffs allow patients to be monitored remotely, reducing the need for frequent hospital visits.
   - **Smart Hospitals**: IoT enables tracking of hospital equipment, patient monitoring, and even environmental controls (e.g., temperature and lighting).
   - **Telemedicine**: IoT devices facilitate virtual consultations between doctors and patients, providing healthcare services to remote areas.

4. **Smart Cities**:

   - **Traffic and Parking Management**: IoT-enabled sensors and cameras monitor traffic flow and parking availability, helping to manage congestion and improve transportation systems.
   - **Smart Lighting**: Streetlights equipped with sensors can adjust their brightness based on motion detection, reducing energy consumption.
   - **Waste Management**: IoT sensors in trash bins can notify municipal services when they need to be emptied, optimizing waste collection routes and improving sanitation.

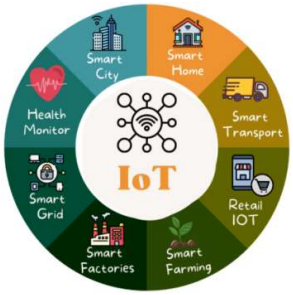
5. **Agriculture and Farming**:

   - **Precision Farming**: IoT devices are used for soil moisture monitoring, crop health analysis, and weather forecasting, enabling farmers to make data-driven decisions to increase yield and reduce resource consumption.
   - **Livestock Monitoring**: IoT sensors can track the health and location of livestock, enabling farmers to monitor animal well-being and improve farm management.

6. **Energy Management**:

   - **Smart Grids**: IoT enables real-time monitoring and control of power distribution networks, helping utilities manage supply and demand, optimize energy use, and prevent outages.
   - **Smart Meters**: Devices that monitor energy consumption in real-time, providing consumers and energy providers with insights to reduce waste and improve efficiency.

## The Future of IoT:



**The IoT ecosystem is rapidly growing and evolving. Key trends to watch for the future include:**

1. 5G Integration: 5G networks will enhance IoT by providing faster speeds, lower latency, and better connectivity for large-scale deployments of IoT devices.
2. AI and Machine Learning: As IoT devices generate more data, AI and machine learning will play an increasingly important role in making sense of this data and enabling smart decisions.
3. Edge Computing: Processing data closer to where it is generated (at the edge) will reduce latency, improve speed, and minimize the amount of data that needs to be sent to the cloud.
4. Blockchain for IoT Security: Blockchain technology may be used to enhance the security and reliability of IoT networks by ensuring tamper-proof data transactions and decentralized control.
5. Autonomous IoT Systems: With the integration of AI and IoT, future systems may operate autonomously without human intervention, in areas like smart cities, smart agriculture, and industrial automation.

**Conclusion:**

The Internet of Things is reshaping industries, enhancing personal experiences, and transforming how we interact with the world around us. As IoT continues to evolve, it promises to unlock new levels of efficiency, convenience, and innovation, while also raising important challenges in areas like security, privacy, and interoperability. The future of IoT will be defined by smarter, more autonomous systems, better connectivity (driven by 5G and beyond), and deeper integration with emerging technologies such as AI, blockchain, and edge computing.

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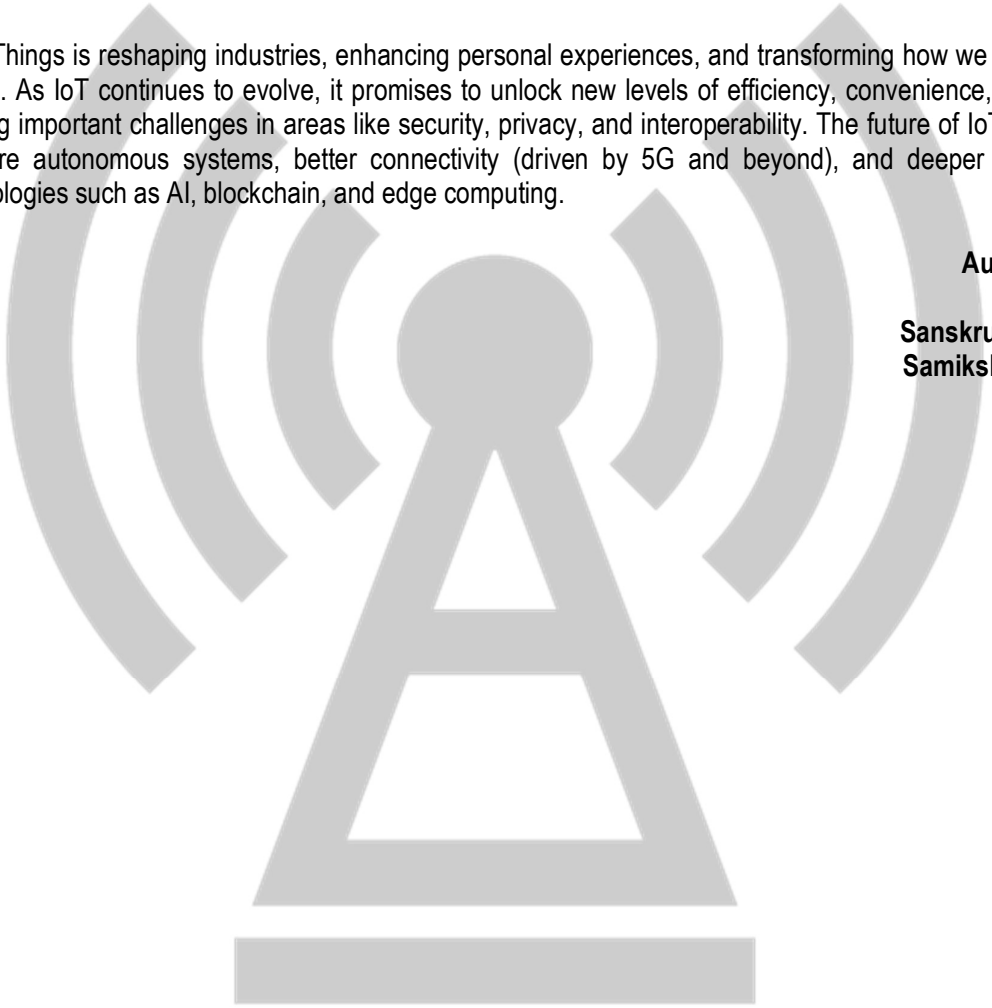
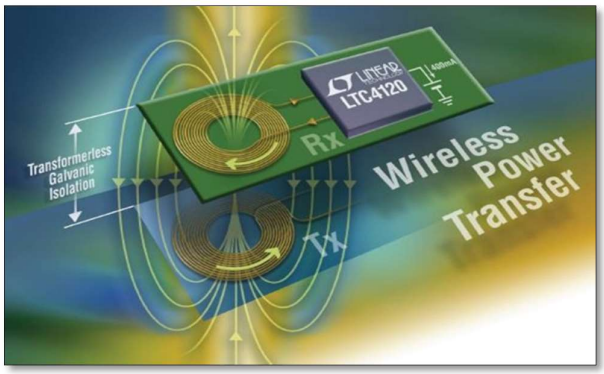


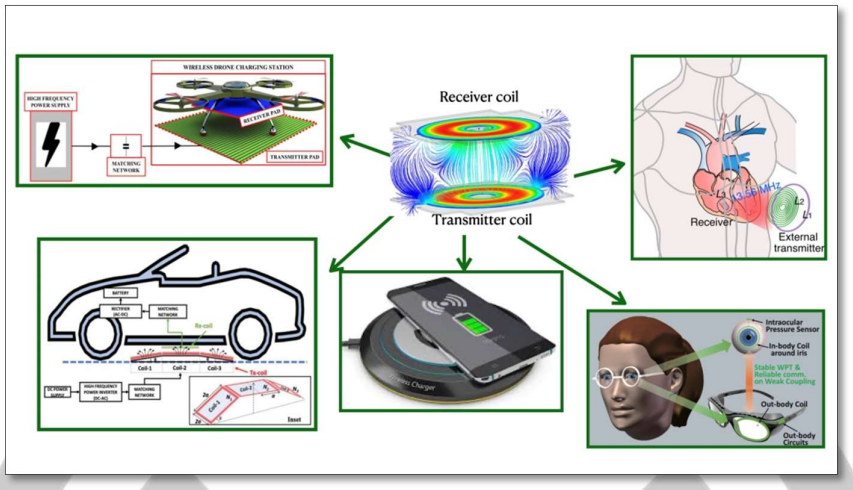
# Wireless Power Transfer

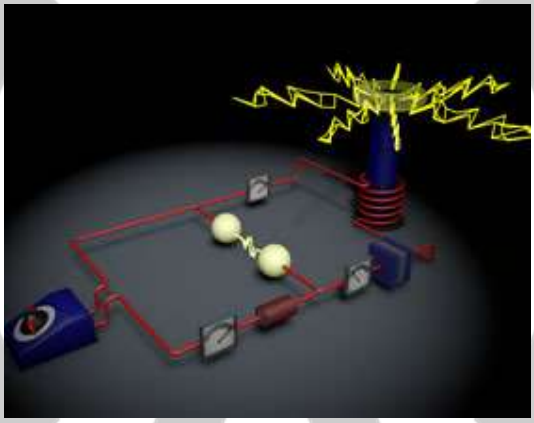



## Introduction

**Wireless Power Transfer (WPT)** refers to the process of transmitting electrical energy from a power source to an electrical load without using physical connectors or wires. WPT allows devices to be charged or powered remotely, offering convenience and flexibility in applications where traditional wired connections are impractical or undesirable. This technology has gained considerable attention in recent years due to its potential to enable new applications in consumer electronics, automotive, medical devices, and industrial systems.

## Principles of Wireless Power Transfer:



WPT relies on the use of electromagnetic fields to transfer energy. There are several methods of achieving wireless power transfer, which include:

1. **Inductive Coupling (Magnetic Induction)**:

    - The most common form of WPT for short-range applications, such as wireless charging for smartphones, electric toothbrushes, and other small devices.
    - **How it works**: Power is transferred via a magnetic field generated by a coil in the charging pad (transmitter) and received by a coil in the device (receiver). The process involves alternating current (AC) that induces a magnetic field in the transmitter coil, which in turn induces a current in the receiver coil.
    - **Efficiency**: Typically, the efficiency is high at short distances but drops off as the distance increases.

2. **Resonant Inductive Coupling**:

    - This method is similar to inductive coupling but uses resonant circuits in both the transmitter and receiver, which are tuned to the same frequency.
    - **How it works**: Both coils resonate at the same frequency, increasing the efficiency of energy transfer, even over larger distances than in standard inductive coupling.
    - **Use Cases**: Used for applications like wireless charging of electric vehicles (EVs) or larger devices where a longer transfer distance is required.

3. **Capacitive Coupling**:

    - Involves the transfer of energy through electric fields between two plates (capacitors).

- **How it works**: Energy is transferred by the variation in the electric field between the transmitter and receiver. The transmitter and receiver are typically made of metal plates or electrodes.
- **Applications**: Capacitive coupling is mostly used for short-range applications like powering small devices or sensors, often with lower efficiency compared to inductive methods.

4. **Microwave Power Transfer**:

   - In this method, energy is transmitted using microwave radiation.
   - **How it works**: Power is converted into microwave radiation and transmitted through the air to a receiver that converts it back into electrical energy. This method works over longer distances compared to inductive coupling but requires high-precision alignment and safety measures.
   - **Applications**: Microwave WPT is still mostly experimental but has potential uses in space, such as power transmission to satellites or from space-based solar power stations.

5. **Laser Power Transfer**:

   - Uses focused laser beams to transfer energy.
   - **How it works**: Laser beams are directed from a transmitter to a receiver that converts the light energy back into electricity. This method has the potential for long-distance wireless energy transfer but requires a clear line of sight.
   - **Applications**: Experimental and niche applications, such as powering remote sensors or drones in the future.

## Advantages of Wireless Power Transfer:

1. **Convenience**:

   - Eliminates the need for physical plugs and cables, making charging and powering devices more convenient.
   - Reduces the clutter of wires and cables, improving the aesthetics and usability of environments.

2. **Safety**:

   - Wireless charging eliminates the risk of electric shock associated with exposed wires and cables, making it safer for consumers.
   - Reduces wear and tear on physical connectors, which can degrade over time.

3. **Remote or Inaccessible Locations**:

   - WPT can provide energy to devices that are difficult to reach or in environments where wired connections are impractical (e.g., underwater sensors, remote monitoring stations, etc.).

4. **Durability and Maintenance**:

    - Wireless-powered devices may have fewer parts that wear out, such as physical connectors, leading to longer lifespans and reduced maintenance needs.

## Applications of Wireless Power Transfer:

1. **Wireless Charging for Consumer Electronics**:

    - **Smartphones, Tablets, and Laptops**: Wireless charging pads or stations allow users to charge their devices without plugging them into cables.
    - **Wearables**: Smartwatches, fitness trackers, and other wearable devices are increasingly using wireless charging solutions.
    - **Headphones and Earbuds**: Many wireless earbuds now use WPT, reducing the need for physical connectors and making them more water-resistant.

2. **Electric Vehicles (EVs)**:

    - **Wireless EV Charging**: WPT can be used to charge electric vehicles by using resonant inductive coupling. This can eliminate the need for physical plugs, providing a more convenient and user-friendly way to charge EVs, particularly in public charging stations.
    - **Dynamic Charging**: Future developments might allow electric vehicles to be charged while in motion (using inductive charging embedded in roadways or highways).

3. **Medical Devices**:

    - **Implantable Medical Devices**: WPT is used to wirelessly power implantable medical devices such as pacemakers, neural stimulators, and drug delivery systems, eliminating the need for batteries and reducing the risk of infections associated with wired connections.
    - **Wearable Health Monitoring**: Devices like smart health patches, continuous glucose monitors, and sensors can be charged wirelessly to ensure continuous monitoring and data collection.

4. **Smart Homes and IoT**:

    - **Wireless Sensors and IoT Devices**: IoT devices, such as smart home sensors, cameras, and environmental monitors, can be powered wirelessly. This helps reduce the need for frequent battery replacements or wiring.
    - **Energy-Efficient Smart Homes**: WPT can provide power to smart home devices such as lighting, thermostats, and voice assistants, enhancing the overall efficiency and convenience of smart living.

5. **Aerospace and Space Applications**:

- **Powering Satellites and Space Stations**: In the space industry, WPT can be used to transmit power from space-based solar panels to Earth-based systems or between satellites.
- **Wireless Charging Drones**: In the future, drones may be powered wirelessly, allowing them to remain airborne for extended periods without the need to land and recharge.

6. **Consumer Products**:

    - **Powering Appliances**: WPT can be used for small household appliances like electric toothbrushes, smart kitchen gadgets, and more.
    - **Toys and Robots**: Many consumer robots and toys are increasingly powered wirelessly, making them easier to use and maintain.

## The Future of Wireless Power Transfer:

1. **5G and IoT Integration**: The advent of 5G and the expansion of the Internet of Things (IoT) are expected to accelerate the development and adoption of wireless power transfer technologies. 5G's high-speed communication capabilities can enable more efficient and reliable power transfer in smart cities, smart homes, and industrial environments.
2. **Innovative Applications**: Future WPT systems might enable dynamic charging of vehicles, continuous charging of mobile devices, and wireless power for larger-scale applications like robots or drones.
3. **Energy Harvesting**: WPT combined with energy harvesting technologies can create self-sustaining devices that don't require conventional charging methods, potentially powering sensors and devices for extended periods in remote or hard-to-reach locations

**Conclusion:**

Wireless Power Transfer is a rapidly advancing technology with the potential to transform the way we power devices and systems. From consumer electronics to electric vehicles, medical devices, and beyond, WPT offers unparalleled convenience and opens the door for new, innovative applications. However, challenges such as efficiency, cost, and standardization must be overcome before widespread adoption can occur. As research and development continue, we are likely to see more practical and efficient solutions that will make wireless power transfer an integral part of our daily lives.

**Author**

**Neel Mehta**
**Adwait More**
**Aman Yadav**
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## ❖ Engineer's Day 2k23:

# ❖Industrial Visit

## 1. GMRT( Giant Microwave Radio Telescope), Khodad, Narayangaon, Pune.


## 2. Celestial Institute of Technology, Pune

## 3. Science Park, Pune


## ❖Expert/Guest lecture

| Expert lecturer Name | Company Name | Topic Name | Actual Date |
|---|---|---|---|
| Mr. Sudhir Matapurkar | Cubix Pvt. Ltd. | Use of PLC Programing In Automation Industry. | 10/08/2023 |

| Expert lecturer Name | Company Name | Topic Name | Actual Date |
|---|---|---|---|
| Mr. Ashutosh Joshi | Zeal College of Engineering & Research, Pune. | Resume Writing, Profile Management, and Interview Preparation. | 05/08/2023 |


| Expert lecturer Name | Company Name | Topic Name | Actual Date |
|---|---|---|---|
| Mr. Shubham Kadam | Softcon, Pune. | Use of PLC Programing In Automation Industry. | 07/09/2023 |

| Expert lecturer Name | Company Name | Topic Name | Actual Date |
|---|---|---|---|
| Mrs Nital Prashant Saraf | IPCS Global, Pune. | Use of PLC and SCADA Application in Industrial Automation | 08/09/2023 |

| Expert lecturer Name | Company Name | Topic Name | Actual Date |
|---|---|---|---|
| **Mr.Shubham Sharma** | ASDC, Pune. | Use of PLC programing in Automation Industry | 07/09/2023 |

# ❖ Student Training Program

| Trainer Name | Company Name | STP Topic Name | Actual Date |
|---|---|---|---|
| Mr. Shubham Kadam | Softcon India Pvt. Ltd. | Matlab Programming | 11/03/2024 |