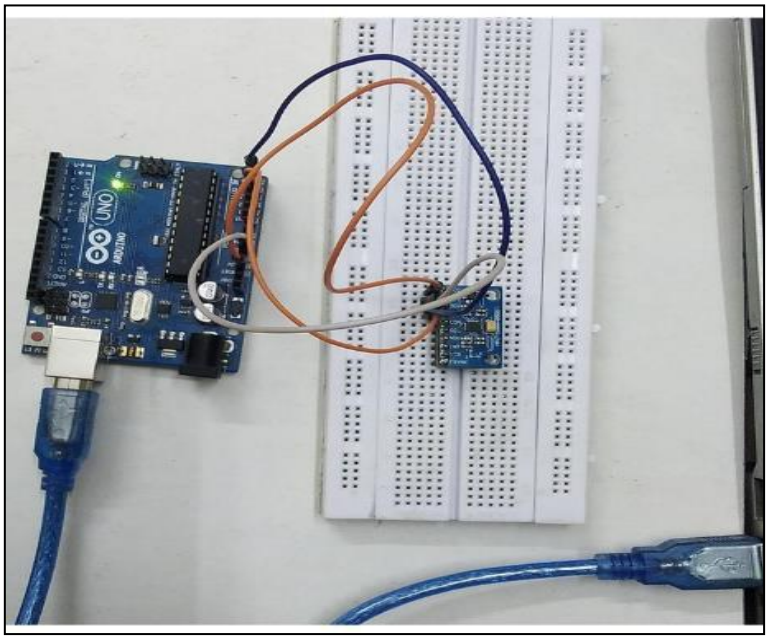
Final Year Project Showcase Batch-2020
Year 2024

	Department: Physics Programme: Applied Physics
1	**Project Title** Development of Physical Conditioning Monitoring System
2	**Project Idea** The project involves the design and implementation of a physical conditioning monitoring system using ESP8266 microcontrollers and MPU-9250 sensors. The system aims to monitor and analyze vibration, orientation, and magnetic fields in real-time to provide valuable insights for predictive maintenance in industrial settings.
3	**Process** -Research and selection of components: ESP8266 and MPU-9250. -Hardware integration and software development for data processing and communication. -User interface design for real-time monitoring. -Testing and validation to ensure accuracy and reliability.
4	**Outcome** A fully functional prototype of a physical conditioning monitoring system that effectively monitors vibration, orientation, and magnetic fields. The system enables predictive maintenance and improves operational efficiency in industrial applications, by comparing the normal and abnormal conditions of DC motors, it do so by setting one DC motor in normal mode having no load while the other motor in abnormal mode by adding loads through nuts, by doing this the system identifies deviations from expected performance. These comparisons allow for early detection of potential failures. The system's ability to distinguish between normal and abnormal motor behavior underscores its effectiveness in supporting predictive maintenance strategies for future work in industry applications.
5	**Evidence (Theoretical Basis)** Predictive maintenance strategies are paramount in an era where machine downtime can significantly impact operational efficiency and profitability. Our project aims to address this challenge by introducing a novel physical conditioning monitoring device leveraging the MPU- 9250 sensor. This sensor, renowned for its accuracy and versatility, enables real-time monitoring of key machine parameters, facilitating predictive maintenance strategies. The device continuously monitors machine parameters such as magnetic flux, acceleration, gyroscopic motion, and temperature, enabling the early detection of potential issues before they escalate into costly breakdowns. The MPU-9250 sensor is the core component responsible for capturing machine parameters, while the ESP8266 microcontroller functions as the communication backbone, facilitating the transmission of sensor data to a central via WiFi. This wireless communication module ensures real-time data transfer to a monitoring system for some analysis, visualization, and power supply. The sensor is mounted on DC motors to analyze real- time vibration patterns and anomalies, and the device utilizes single-board computers (SBC) such as ESP boards to save processing data locally. Real-time setup, control, and data access are facilitated through a software analyzer, with data presented using a graphical user interface programmed in Python, providing a

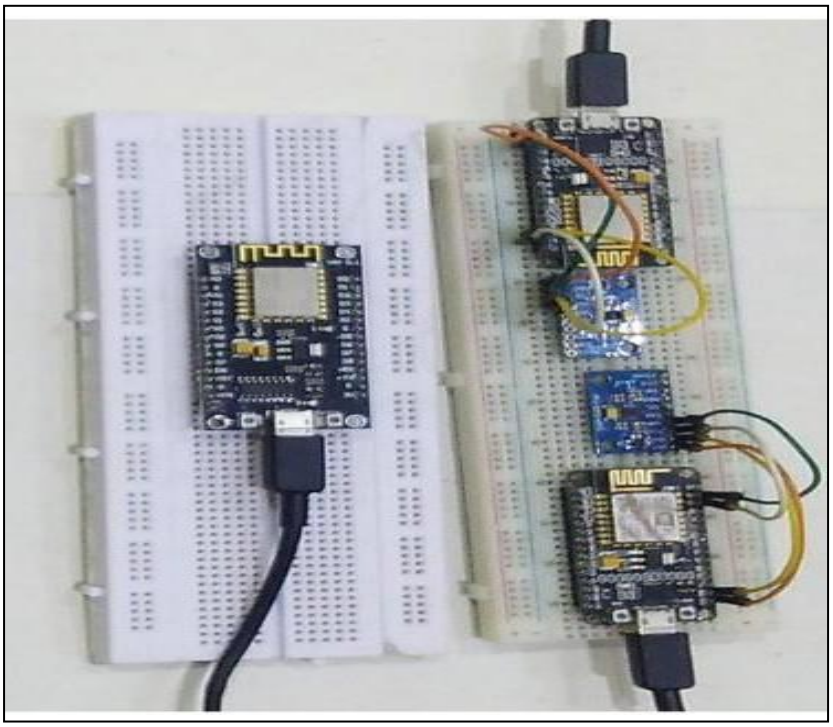
	comprehensive and user-friendly visualization of machine performance. This project has wide applications in industries where machinery is integral to operations, including manufacturing, automotive, aerospace, and energy sectors. By implementing this simple condition monitoring system according to their requirements and complexities, businesses can enhance operational efficiency, reduce downtime, and improve overall profitability through proactive maintenance and early issue detection.
6	**Competitive Advantage or Unique Selling Proposition** (Cost Reduction, Process improvement, Attainment of any SDG (Sustainable Development Goal), increase of market share or capturing new market or having superior performance over a competitor. In summary, any striking aspect of the project that compels the industry to invest in FYP or purchase it. Some detailed description is required in terms of how, why when what. You can select one or more from the following dropdown and delete the rest of them). Please keep relevant options, delete the rest of them, and correct the sequence
a	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region) The project contributes to Sustainable Development Goal 9 (Industry, Innovation, and Infrastructure) by directly enhancing the efficiency and sustainability of industrial operations through predictive maintenance. According to the United Nations, SDG 9 emphasizes building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. By implementing a condition monitoring system that detects early signs of wear and malfunction in DC motors, this project further advancements can reduce unplanned downtime by up to 30% and lower maintenance costs by 20-25%, according to industry studies on predictive maintenance. This leads to a more efficient use of resources, reduced waste from unnecessary part replacements, and extended equipment life, which aligns with the goal of fostering sustainable industrial practices. Additionally, the integration of innovative technologies like the MPU-9250 sensor and ESP32 microcontroller showcases how modern digital solutions can revolutionize traditional industries, further supporting the advancement of resilient and sustainable industrial infrastructure.
b	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** (e.g. What is the issue is current process and what improvement you suggests) Traditional machinery monitoring methods, which often involve periodic inspections and scheduled maintenance, are inherently limited in their ability to detect early signs of equipment failure. These methods can lead to several inefficiencies, such as over-maintenance, where maintenance is performed more frequently than necessary, and under-maintenance, where critical issues are missed, resulting in unexpected equipment breakdowns. According to a study by McKinsey & Company, unplanned downtime in manufacturing costs companies an estimated $50 billion annually, with equipment failure being the cause of 42% of this downtime. Furthermore, a study by the Aberdeen Group found that the average cost of unplanned downtime is $260,000 per hour across industries, emphasizing the significant financial impact of reactive maintenance strategies. To address these issues, the implementation of a real-time condition monitoring system is proposed. The system continuously monitors key parameters such as vibration, orientation, and magnetic fields, providing early detection of potential failures. Research indicates that predictive maintenance, supported by such real-time monitoring systems, can reduce maintenance costs by 20-30%, extend the life of equipment by 20-40%, and decrease unplanned downtime by up to 30%. For example, a study by Deloitte highlighted that predictive maintenance can lower breakdowns by 70% and cut maintenance costs by 25%. By transitioning from traditional methods to this data-driven approach, industries can significantly improve operational efficiency, reduce costs, and

	enhance the reliability of their machinery, making it a crucial advancement in industrial maintenance practices.	
c	**Capture New Market** (e.g. Niche market or unaddressed segment) The system is designed to cater to industries where continuous monitoring of physical conditions is critical, targeting a niche market in predictive maintenance within sectors such as manufacturing, energy, and transportation.	
7	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service The system is designed to address the needs of industries where continuous monitoring of physical conditions is vital, such as manufacturing, energy, and transportation. In manufacturing, equipment failures can lead to substantial production losses and safety risks, with downtime costs. The energy sector, particularly in power generation and oil and gas, faces severe economic impacts from equipment breakdowns, with potential costs reaching millions of dollars per day due to halted operations. Similarly, the transportation industry, including railways and aviation, depends on the reliability of its machinery to ensure safety and avoid costly delays. This targeted approach supports critical infrastructure by proactively addressing issues before they escalate, leading to more efficient and reliable industrial operations.	
8	**Team Members** (Names along with email address)	Zarafshan Fatima (Email: azadzarafshan03@gmail .com) Fatima Zehra (Email: fatimazehra685@gmail.com) Moazzama Rabbani (Email: rabbanimoazzama@gmail.com) Mahrukh Shakil (Email: shakilmahrukh@yahoo.com)
10	**Supervisor Name** (along with email address)	- Dr. Irfan Ahmed (Email: irfans@cloud.neduet.edu.pk) -Ms. Ayesha Khurshid (Email: ayeshakd@neduet.edu.pk)
11	**Video (If any)**	https://youtu.be/WcHkbhVVrL8

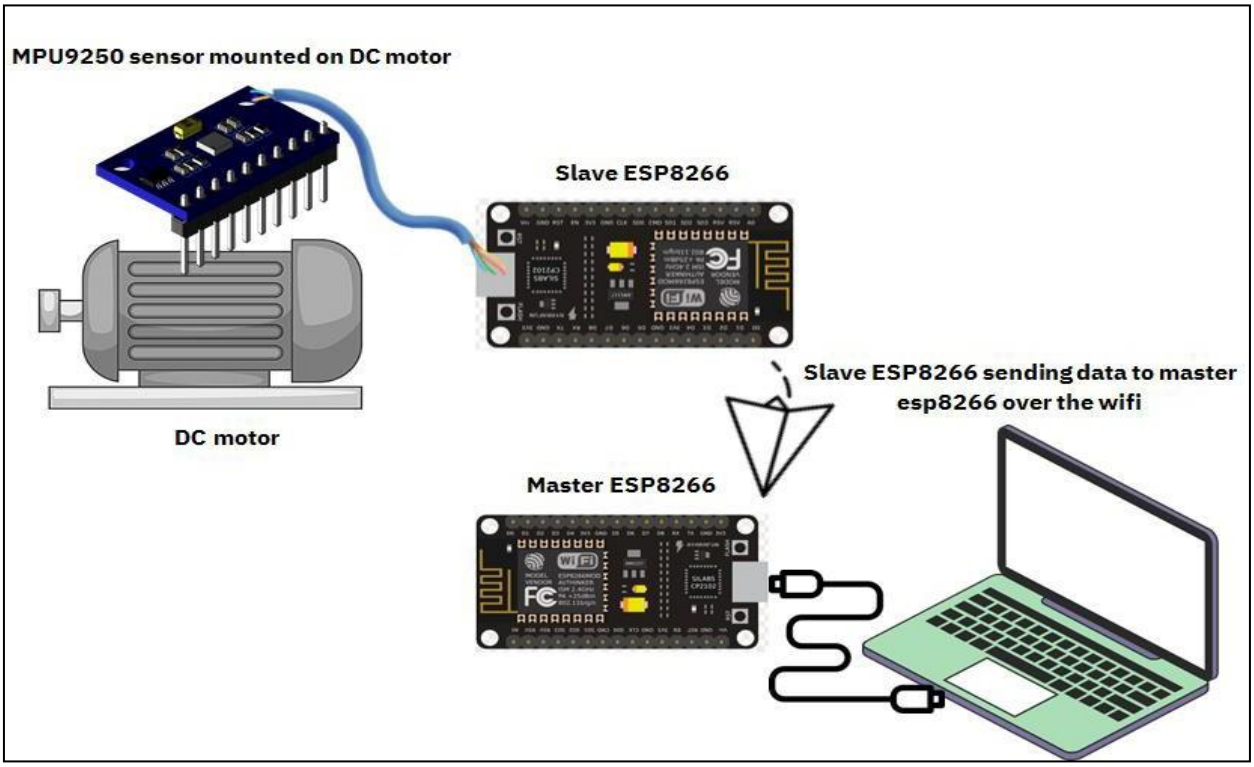
Initial Setup of MPU9250 Sensor:



Setting up Protocols for Communication:



Final Setup:



This project is designed and developed with collaboration of MODBee Technologies.

INDUSTRIAL SUPERVISOR:

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