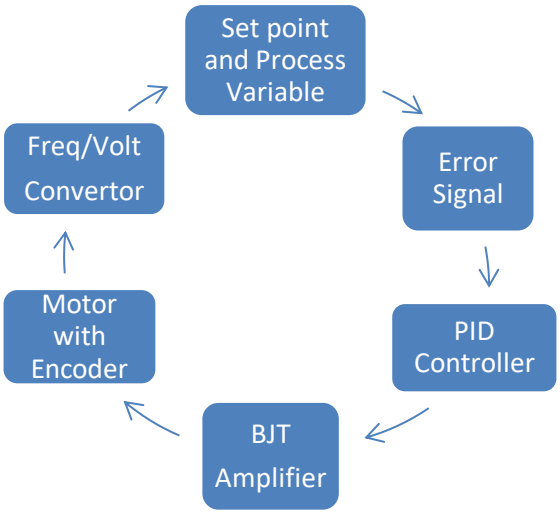
Final Year Project Showcase Batch 2020
Year 2024

Department: Electrical Engineering
Programme: Electrical Engineering

1	**Project Title** Design and development of a Motor controller for Industrial Automation
2	**Project Idea** In Pakistan's industrial sector, DC motors are integral to numerous applications, yet the lack of affordable and locally produced motor controllers significantly limits their precise speed control. Existing solutions, which predominantly rely on imported PID-based motor controllers, are costly and often come with complex tuning requirements, making them inaccessible to many local industries. This project aimed to bridge this gap by designing and developing a cost-effective, locally manufactured analog PID motor controller tailored for robust industrial use. The controller was designed to offer precise speed regulation for DC motors, essential for improving automation across various industries. PID (Proportional-Integral-Derivative) control, widely used in nearly 95% of all closed-loop systems, provides an ideal solution due to its ability to generate accurate control signals by adjusting its proportional, integral, and derivative parameters. By utilizing this method, our project succeeded in creating a motor controller that delivers fast response times, minimizes errors, and is easy to tune.
3	**Process** Our design of an analog PID motor speed controller includes design and simulation on Proteus software and hardware on Vero board. It begins with defining the set point and process variable, which are compared using a comparator to generate an error signal. This error signal is processed through Proportional (P), Integral (I), and Derivative (D) components, each designed with specific operational amplifiers to handle their respective functions. The outputs from these components are summed using a summer circuit, which integrates the combined control signal. This integrated signal is then amplified using TIP122 and TIP127 BJTs to ensure it can drive the DC motor efficiently. The motor's speed is continuously monitored using an encoder, which provides high-resolution feedback by generating square pulses whose frequency is proportional to the motor's RPM. This frequency signal is converted to a corresponding voltage using the LM2907 Frequency-to-Voltage Converter, creating the analog voltage output. This variable is then fed back into the comparator, closing the control loop and ensuring precise and stable motor speed regulation based on the PID control strategy. 

4	**Outcome** The outcome of our analog PID motor speed controller project, although not yet fully completed, has yielded promising results in several areas. We successfully developed and tested the Frequency-to-Voltage Converter, which functions accurately, and the encoder, which provides reliable feedback on motor speed. Furthermore, our PID control system works well, demonstrating effective motor speed regulation with minimal overshoot and steady-state error. However, we encountered challenges in integrating the encoder with the Frequency-to-Voltage Converter due to distorted pulses from the encoder. These distortions have highlighted the need for further signal conditioning to ensure clean, precise pulses for accurate conversion. Despite these integration issues, the individual components and the PID control system have demonstrated their potential, and the groundwork has been laid for further refinement and successful completion of the project. The insights gained thus far have been invaluable, guiding us toward the necessary adjustments and improvements required to achieve a fully functional and robust PID motor speed controller.
5	**Evidence (Theoretical Basis)** Our project aims to address the need for locally built DC motor speed controllers for industrial automation by utilizing an analog PID (Proportional-Integral-Derivative) control technique. PID control is a widely used method in control systems due to its simplicity and effectiveness in providing stable and responsive control. The Proportional component (P) responds to the current error, the Integral component (I) accounts for the accumulation of past errors, and the Derivative component (D) predicts future errors based on the rate of change, together ensuring minimal overshoot and steady-state error. To achieve this, we began with extensive simulations using Proteus software, where we meticulously designed and validated the PID controller's performance. These simulations helped us fine-tune the algorithm for optimal performance and stability. Building on the successful simulations, we proceeded to construct the hardware on a Vero board. Our design includes a comparator to generate the error signal, Proportional (P), Integral (I), and Derivative (D) components for precise control, and a summer circuit to integrate these signals. We used TIP122 and TIP127 BJTs for amplifying the control signal to drive the DC motor. The motor's speed is monitored by an encoder, which provides feedback in the form of a frequency signal. This signal is converted to a voltage using the LM2907 Frequency-to-Voltage Converter to close the control loop. While our PID control system works well and individual components like the Frequency-to-Voltage Converter and the encoder have been successfully tested, we encountered challenges with integrating these components due to distorted pulses from the encoder. This has highlighted the need for additional signal conditioning. Despite these challenges, our project has laid a solid foundation for developing a robust, locally built DC motor speed controller for industrial applications. The theoretical knowledge and practical insights gained through this project will guide us in making the necessary adjustments and improvements to achieve a fully functional and effective motor speed control system.
6	**Impact on Sustainability of Urban Regions or SDG-11 "Sustainable Cities and Communities"** The development of the analog PID motor controller for industrial automation supports SDG-11, particularly Target 11.6, which aims to reduce the environmental impact of cities by promoting energy efficiency. By providing a locally manufactured, cost-effective solution for precise motor speed control, this project contributes to more efficient industrial processes, reducing energy consumption and waste. Additionally, it indirectly supports the objectives of Target 11.1 for sustainable economic growth by making advanced automation technology accessible to local industries, fostering innovation,

	and promoting sustainable industrial practices in urban areas. The project aligns with the broader goals of creating energy-efficient, sustainable, and resilient urban communities.
7	**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) **SDG#11: Sustainable Cities and Communities:** Our project aligns with SDG-11, particularly by promoting energy-efficient industrial processes, which is crucial for reducing the environmental impact of urban areas. In Pakistan, industrial sectors in cities contribute significantly to energy consumption and pollution. By developing a cost-effective, locally manufactured analog PID motor controller, we provide industries with a solution that improves automation and reduces energy wastage through precise motor control. This energy efficiency directly contributes to reducing the carbon footprint of industrial operations, supporting Target 11.6, which aims to lower the environmental impact of cities. Furthermore, fostering local innovation and production is vital for the region, as it reduces dependency on expensive imports and encourages economic sustainability. The availability of affordable, efficient motor controllers enables small and medium-sized enterprises (SMEs) to adopt modern automation, which is necessary for sustainable industrial growth in urban areas. By ensuring that industries can operate more efficiently and sustainably, this project helps build more resilient, eco-friendly urban communities, advancing the broader goals of SDG-11.
b	**Environmental Aspect** The design and development of our analog PID motor controller for industrial automation emphasize not only cost-effectiveness but also environmental sustainability. DC motors are widely used in various industrial applications, and optimizing their performance through precise control can significantly reduce energy consumption. By improving the efficiency of motor speed regulation, our controller ensures that motors operate at optimal power levels, reducing unnecessary energy usage and, consequently, carbon emissions. Additionally, the locally manufactured nature of the controller reduces reliance on imported products, minimizing the carbon footprint associated with shipping and transportation. The project's focus on enhancing energy efficiency aligns with global efforts to reduce industrial energy consumption and greenhouse gas emissions, contributing to a more sustainable industrial ecosystem in Pakistan.
c	**Cost Reduction of Existing Product** Currently there is no such product available in local market.
d	**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) In the current industrial landscape, motor controllers are vital for ensuring precise DC motor speed regulation. However, the process of acquiring and implementing existing motor controllers is often hindered by high costs, complex tuning requirements, and dependency on imported solutions. These challenges create significant barriers, particularly for small to medium-sized enterprises that need cost-efficient yet reliable solutions to improve their production processes. Our project addresses these issues by developing a locally manufactured, cost-effective analog PID motor controller. Unlike existing imported controllers, which require complex adjustments and expensive resources, our solution simplifies the tuning process while maintaining high precision in motor control. This improvement

	reduces downtime and operational costs, as industries can now implement a reliable controller with minimal setup and maintenance efforts. To further enhance the system, future improvements could include integrating advanced features such as automated tuning algorithms and adding more robust components to withstand extreme industrial conditions. These enhancements would take the product to a commercial scale, making it even more efficient and applicable to a wider range of industrial settings.	
e	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market DC motors, renowned for their high starting torque, quick response, and linear control, have been a mainstay in industrial control systems. To effectively manage factors like position or speed, motor controllers are indispensable. While foreign-made motor controllers are available, their high import costs pose a significant challenge for Pakistan's industries. PID controllers, a proven method for closed-loop control, offer a reliable solution. These controllers, used in over 95% of industrial applications, enable precise control by adjusting system output based on feedback. They compensate for inconsistencies arising from equipment, environmental factors, and even product variations in the manufacturing process. The absence of locally manufactured motor controllers in Pakistan presents an opportunity for domestic industries to develop and produce these essential components. By investing in research and development, Pakistan can not only reduce its reliance on imports but also create new jobs and stimulate economic growth.	
f	**Capture New Market** (e.g. Niche market or unaddressed segment) By specializing PID controllers for industries with unique requirements, such as aerospace, medical equipment, or robotics, manufacturers can gain a competitive edge. As developing economies grow, there is a rising demand for industrial automation and control systems. PID controllers can play a significant role in these markets by providing affordable and reliable solutions. Manufacturers can capitalize on this growth by establishing partnerships or setting up local operations in emerging regions. Also, by continuously enhancing PID controller performance through advancements like adaptive tuning, hybrid control, or machine learning can attract new customers seeking more sophisticated and efficient control solutions.	
g	**Any Other Aspect (Please tag it like above options)**	
8	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service **PID controllers** are used in various industries, including manufacturing, energy, robotics, aerospace, automotive, and building automation. They are used by engineers, researchers, maintenance personnel, hobbyists, educators, and homeowners. End-users of PID controllers often share common needs**:** • Ensuring that processes are controlled to a high degree of precision and accuracy. • Optimizing energy consumption and resource utilization. • Ensuring that control systems are reliable and can operate without frequent failures. • Preventing accidents and ensuring the safety of personnel and equipment. Minimizing operating costs and maximizing return on investment.	
9	**Team Members** (Names along with email address	Muniba Ansari (GL) : munibaaqil@gmail.com Rumaisa Idrees : rumaisaidrees66@gmail.com Hafsa Usman : hafsausman43@gmail.com Wareesha Azwar : wareeshaazwar227@gmail.com
10	**Supervisor Name** (along with email address)	Dr. Riaz Uddin, Associate Professor , Electrical Engineering Department, NEDUET riaz.nedian@gmail.com

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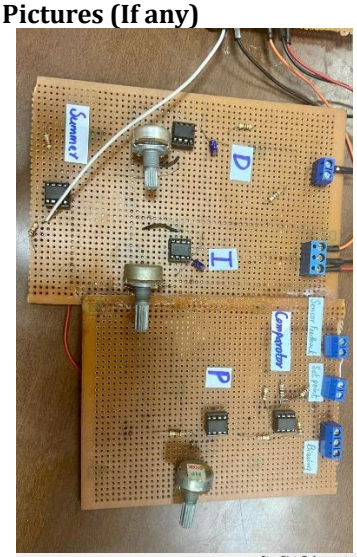
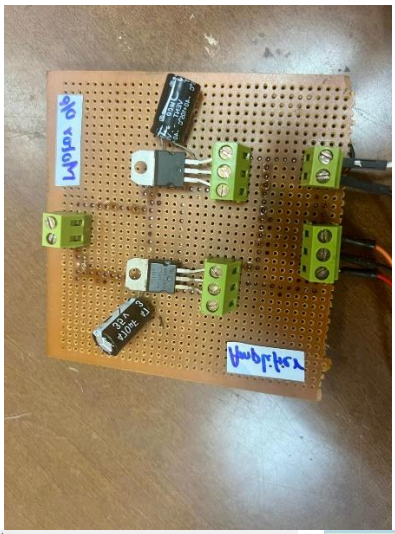
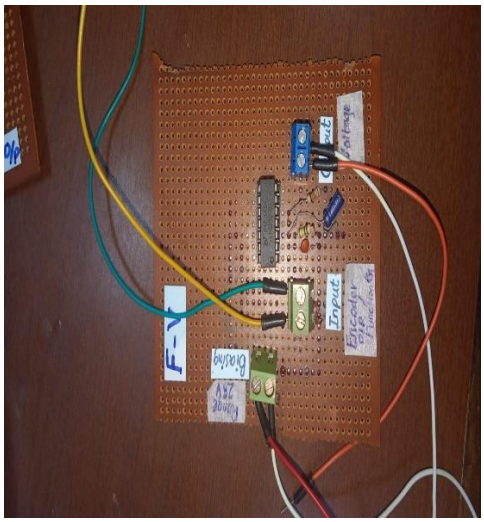
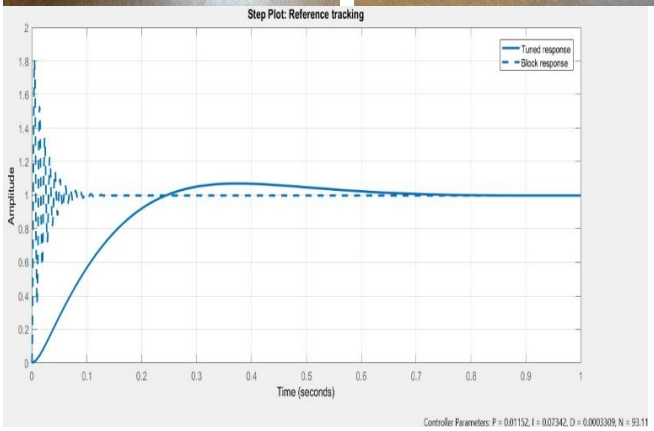
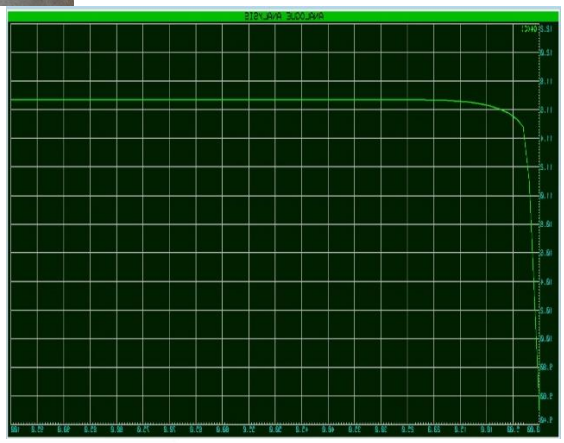
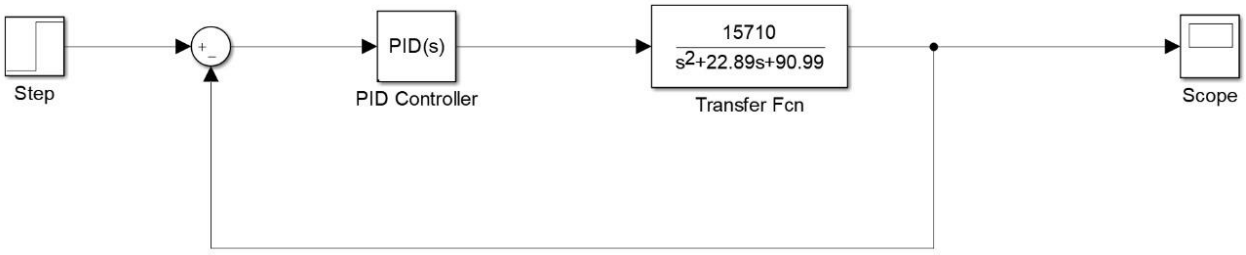
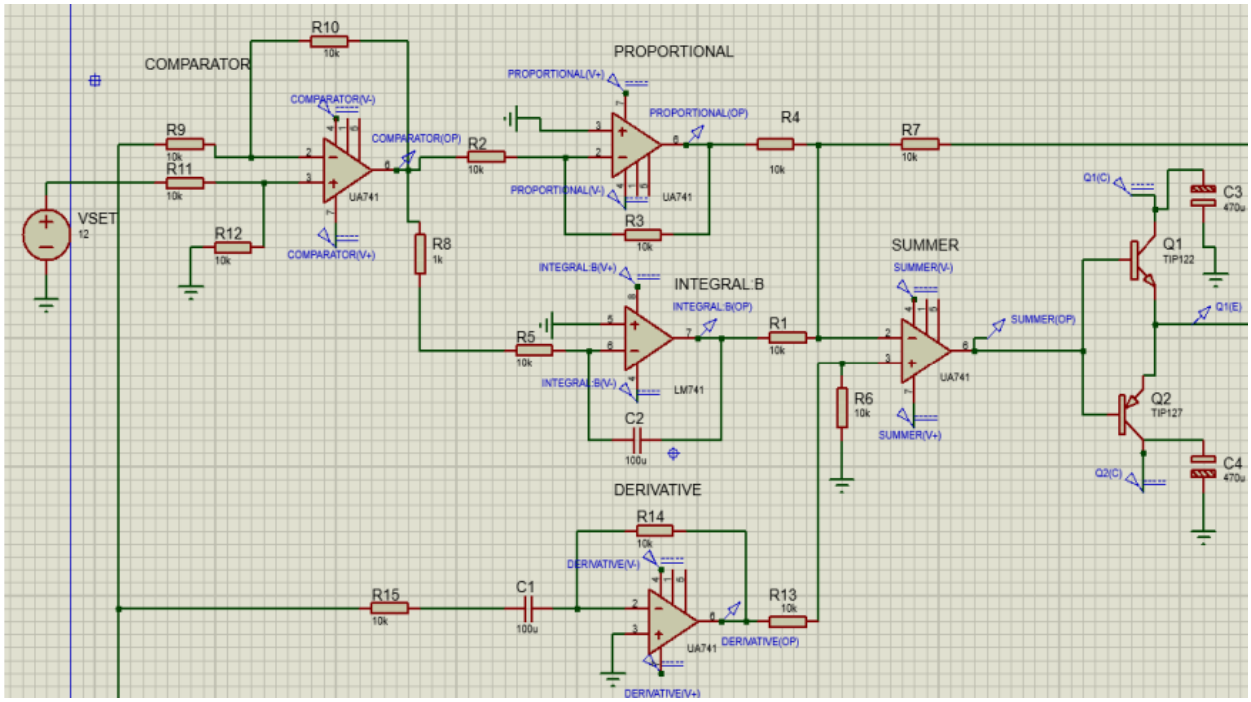
ss11	**Video (If any)**	https://drive.google.com/file/d/1dXLITKHs-2yE986RsgPPvR5cenR4mN02/view?usp=sharing https://drive.google.com/file/d/1libZPwRbKF-Pu5F1J-3zqIAeRR1vNdv7/view?usp=sharing

Pictures (If any)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