Final Year Project Showcase Batch-2021
For the Year 2025

Department of Automotive &Marine Engineering Name of Programme: BE in Automotive Engineering		
1	**Project Idea**	**Project Title**:Revamping of Dent Resistance Tester Machine with Incubation of Real-Time Data Processing with Industrial Standards. Our project involved breathing new life into an old, non-functional dent resistance tester machine that had been handed down by a previous group. While the mechanical frame was intact, the machine failed to collect or produce any meaningful data. We took on the challenge to **completely revamp its hardware and software**, aligning the system with **SAE J2575 industrial standards**.We integrated **real-time data acquisition**, designed a Python-based **GUI for live test monitoring**, and automated the pneumatic actuation using an Arduino microcontroller setup. This transformation allowed the machine to deliver traceable, accurate, and repeatable dent test results, making it useful for academic research, industrial applications, and educational training.
2	**Process**	We inherited a non-functional dent tester with an intact mechanical frame but missing electronics and sensing. Our team completely revamped the system to meet SAE J2575 standards. Key upgrades included: • Integrated a **compressed air reservoir system** with proper pneumatic piping, fittings, and a **manual pressure regulator** to control output force. • Added a **pressure gauge** for real-time monitoring and a **solenoidal valve** to automate airflow control. • Used a **double-acting pneumatic cylinder** for consistent, repeatable indent cycles. • Installed a **KTC-50 displacement sensor** and **S-type load cell (HX711 amplifier)** for real-time force and displacement tracking. • Controlled the system with an **Arduino Uno**, enabling data acquisition and solenoid actuation. • Developed a **Python-based GUI** for real-time **force-displacement plotting** and automatic result logging. This transformation turned an inactive setup into a fully operational, research-grade machine, bridging academic learning with industrial application.
3	**Outcome**	We delivered a fully functional dent resistance tester with real-time force-displacement monitoring through our custom-built Python GUI. The machine performed **SAE J2575** compliant tests accurately and consistently. It eliminated reliance on expensive foreign systems and can now be reused for lab experiments, student training, and materials research supporting localized R&D in line with Pakistan's industrial development goals.

4	**Evidence (Theoretical Basis)**	Our project was developed in line with **SAE J2575**, covering both **quasi-static and dynamic dent resistance testing** standards. The system applies core theories from **mechanics of materials, sensor integration, control systems, and automation**. We implemented a fully integrated setup using load and displacement sensors, pneumatic actuation, and a Python-based GUI for real-time analysis. The machine successfully replicates **both static and impact-based indentation scenarios**, offering results comparable to industrial-grade testers. This demonstrates how **low-cost, locally built solutions** can fulfill international testing requirements across both static and dynamic domains.
5	**Competitive Advantage or Unique Selling Proposition:** Our project offers a clear competitive edge through significant **cost reduction**, replacing expensive imported dent testers with a **locally developed, open-source solution** built using accessible components. It brings notable **process improvements** by enabling real-time data acquisition, automated pneumatic control, and full compliance with SAE J2575 standards—eliminating manual errors and improving testing reliability. The system supports both **quasi-static and dynamic dent resistance testing**, giving it a **performance advantage** over conventional or limited-function setups. In addition, the project strongly supports multiple **Sustainable Development Goals (SDGs)**. It contributes to **Decent Work and Economic Growth (SDG 8)** by encouraging hands-on technical skill development and empowering local engineering talent. It addresses **Industry, Innovation, and Infrastructure (SDG 9)** by modernizing outdated testing setups and promoting self-reliant technological innovation. Finally, it aligns with **Responsible Consumption and Production (SDG 12)** by reusing existing mechanical structures and reducing dependence on imported systems. Together, these features make our project a compelling, scalable, and sustainable solution for academic and industrial adoption.	
a	**Cost reduction of existing Product**	Commercial dent resistance testers with SAE J2575 compliance and real-time data logging, such as those offered by manufacturers in China, are priced between **USD 100,000 to 200,000 per unit**. In contrast, our system was developed locally at a total cost of **PKR 65,000**, including a complete pneumatic reservoir setup, sensor integration, data acquisition software, and basic structural components. While we optimized available resources to reduce costs, the final system successfully replicates the **core functions of high-end imported machines,** achieving real-time, standards-compliant dent testing at **less than 1% of the global market price**.
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 dent resistance testing methods are either **fully manual**, lack real-time feedback, or require **high-cost imported systems** for automated control and data capture. Such setups often suffer from inconsistent force application, no live data visualization, and limited repeatability. Our system addresses these issues through: • **Automated pneumatic actuation using a solenoidal valve**, ensuring consistent indentation cycles • **Real-time data acquisition and force–displacement plotting**, enabling instant result analysis • **Standardized testing procedures aligned with SAE J2575**, improving reliability and traceability • **Simplified operation and faster test execution**, reducing testing time and human error These process improvements result in a **cost-effective, accurate, and industrially relevant testing workflow**, bridging the gap between academic setups and professional testing standards.

c	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region)	This project supports multiple Sustainable Development Goals (SDGs) directly relevant to the region. It promotes **SDG 9 (Industry, Innovation, and Infrastructure)** by enabling local development of standardized testing equipment that would otherwise require costly imports. Through hands-on engineering and low-cost development, it advances **SDG 8 (Decent Work and Economic Growth)** by equipping students with real-world technical skills and fostering innovation within academic institutions. Furthermore, by **reusing existing mechanical structures** and optimizing local resources, the project aligns with **SDG 12 (Responsible Consumption and Production)**, minimizing waste and maximizing value from available assets. These contributions are vital for building a **self-reliant, technically skilled, and sustainable engineering ecosystem** in Pakistan.
d	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market	The **global automotive test equipment market** is valued at over **USD 3.3–3.8 billion**, and projections suggest it will grow to **USD 4.5–5.6 billion by 2030**, driven by rising safety standards, increasing vehicle production, and the shift toward electric and autonomous vehicles Despite this, most small-scale and academic users are priced out, since such machines typically cost **USD 100,000–200,000** and cater to large OEMs . Our locally developed system addresses this gap by offering **comparable real-time, SAE-compliant dent testing capabilities** at a total cost of **under PKR 65,000 (≈ USD 200)**. By targeting academic institutions, small automotive parts manufacturers, and research labs in regions like Pakistan, where the automotive sector contributes approximately **4% to GDP and employs over 1.8 million people** we tap into a high-growth, underserved niche. In doing so, the project not only **opens up new cost-sensitive markets** but also positions itself as a scalable model for **low-cost industrial-grade testing equipment**, actively growing market penetration and enabling broader adoption of compliant testing infrastructure in developing economies.
e	**Capture new market (**e.g. Niche market or unaddressed segment**)**	Our product targets a **niche market segment** currently underserved: **academic institutions, technical universities, small automotive workshops, research labs, and low-budget testing facilities** that require reliable dent resistance testing but cannot afford commercial-grade machines priced at USD 100,000 or more. By offering **core functionality at under PKR 65,000**, our system opens up access to **standard-compliant testing** for organizations and regions that were previously priced out of the market. This positions the product uniquely in the **low-cost, standards-compliant testing equipment category**.
f	**Any Environmental Aspect** (e.g. carbon reduction, energy-efficient, etc.)	The project supports **SDG 12 – Responsible Consumption and Production** by **repurposing an existing mechanical frame**, reducing material waste and extending equipment life. It uses a **low-power Arduino** and **energy-efficient air compressor**, minimizing energy use compared to industrial machines. Its **compact, repairable design** promotes sustainability and aligns with green engineering principles.
g	**Any Other Aspect**	The project also serves as a **learning and skill-development platform** for engineering students. Its multidisciplinary nature, spanning mechanics, pneumatics, sensors, controls, and software, makes it ideal for **coursework, lab demos, and student projects**. With its ease of use and real-time visualization, it's a valuable **academic tool for teaching material testing fundamentals** beyond its original FYP scope.

6	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service	The primary target market includes: • **Engineering universities and technical colleges** looking to upgrade their lab testing capabilities • **R&D departments** of automotive companies or component suppliers interested in low-cost prototyping • **Small manufacturing units** involved in sheet metal or panel-based fabrication • **Vocational training institutes** focused on hands-on testing equipment • **Engineering students and faculty** seeking affordable, standards-based testing setups for learning and research This solution is especially relevant in regions like **South Asia, Africa, and Southeast Asia**, where testing infrastructure is limited but growing.
7	**Team Members (Names & Roll No.)**	**1.** Talha Bin Wasi Au-21021 **2.** Umair Adil Au-21022 **3.** Muhammad Farzan Hussain Au-21025 **4.** Mian Muhammad Junaid Au-21034
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10	**Pictures (If any)**