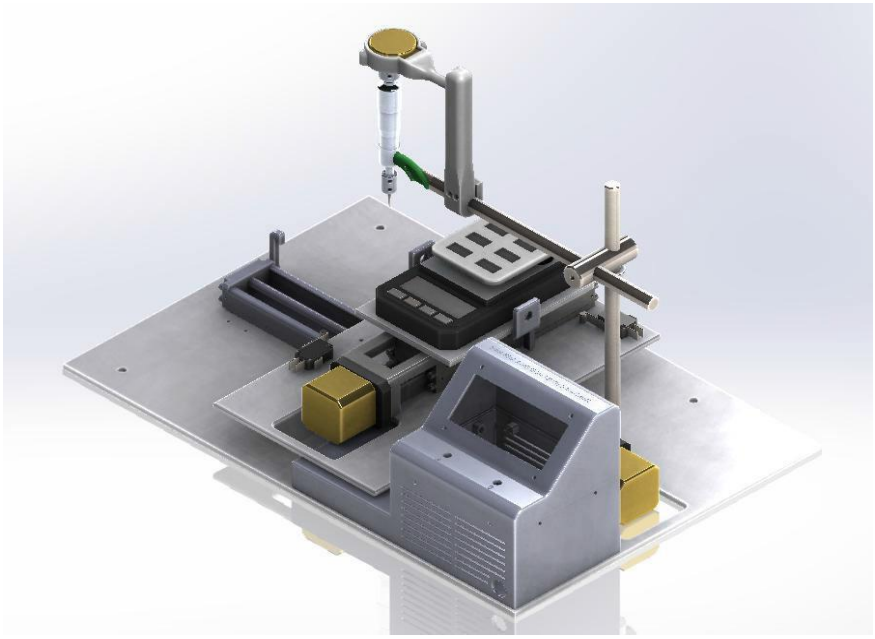
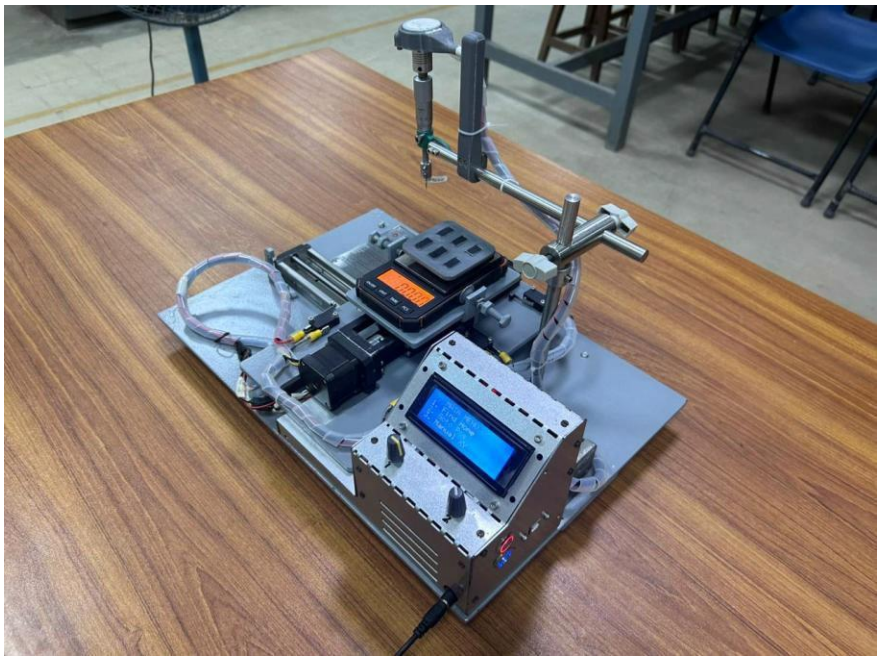
Final Year Design Project Showcase
Batch-2022
Year 2026

Department: Mechanical Engineering Programme: Mechanical Engineering	
1	**Project Title** Design and Fabrication of a Thin Film Adhesion Testing Machine
2	**Project Idea** To design and fabricate a low-cost laboratory-scale thin film adhesion testing machine that evaluates coating adhesion using the micro-scratch test. The system provides precise X–Y motion, controlled indenter positioning, and indirect force measurement, providing an affordable alternative to expensive commercial scratch-testing equipment.
3	**Process** 1) Designed the machine using SolidWorks and validated the structure through ANSYS simulations. 2) Selected and integrated THK linear guide actuators, stepper motors, and an ESP32-based control system. 3) Fabricated and assembled the mechanical structure. 4) Implemented precision motion control and force measurement using a digital balance. 5) Performed experimental validation to verify motion accuracy, structural stability, and force transmission.
4	**Outcomes** 1) Successfully developed a functional laboratory-scale thin film adhesion testing machine. 2) Achieved precise and repeatable X–Y scratch motion. 3) Verified structural integrity through finite element analysis. 4) Demonstrated stable force transmission and controlled adhesion testing. 5) Developed a low-cost laboratory-scale alternative to commercial scratch-testing systems.
5	**Evidence (Theoretical Basis)** The project is based on the principles of thin film adhesion evaluation using the micro-scratch test, where coating failure is determined by applying a controlled load through an indenter while moving the specimen under precise linear motion. The design incorporates ball-screw-driven THK linear actuators for accurate positioning, a micrometer-based Z-axis for precise indenter adjustment, and an ESP32-controlled motion system for automated operation. Structural integrity was validated through ANSYS finite element analysis, while engineering calculations were performed for actuator loading, torque requirements, and motor selection. Experimental testing confirmed smooth motion, stable force transmission, and reliable system performance, demonstrating that the developed prototype is a practical and economical alternative for laboratory-scale adhesion testing.

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** SDG 9 – Industry, Innovation and Infrastructure The project promotes affordable research infrastructure by providing a locally manufactured testing system that supports material characterization, innovation, and industrial research. It reduces dependence on imported testing equipment and encourages indigenous engineering development.
b	**Cost Reduction of Existing Product** Commercial thin film scratch testers typically cost between USD 20,000–150,000, making them unaffordable for many universities and small laboratories. This project offers a significantly lower-cost alternative using locally available components while retaining the essential functionality required for laboratory-scale adhesion testing.
c	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** The machine employs a stationary indenter with precise X–Y specimen movement, reducing vibration and improving scratch consistency. The modular design simplifies fabrication, maintenance, and future upgrades while providing reliable and repeatable testing results.
d	**Any Other Aspect** The system features a modular architecture that can be upgraded with automatic force control, real-time data acquisition, computer interfacing, and image processing, making it suitable for future commercialization and advanced research applications.
7	**Target Market** The primary target market includes universities, research laboratories, R&D departments, materials science laboratories, semiconductor and MEMS research centers, coating and surface engineering industries, manufacturing quality control laboratories, and organizations involved in thin film characterization. The machine is particularly suitable for institutions requiring an affordable adhesion testing solution without investing in expensive commercial equipment.

8	**Team Members** (Names along with email address)	Saad Nawab — nawab4508974@cloud.neduet.edu.pk Muhammad Muaaz Bin Riaz — riaz4502711@cloud.neduet.edu.pk Muhammad Jaffer Ali Ameen — ali4560042@cloud.neduet.edu.pk Aon Muhammad — muhammad459994@cloud.neduet.edu.pk
10	**Supervisor Name** (along with email address)	Professor Dr. Murtuza Mehdi — drmurtuza@neduet.edu.pk
11	**Video (If any)**	https://drive.google.com/file/d/1-UpziaDNjk1wgjYTOqDvnCdeZORSCL-h/view?usp=drive_link

Pictures