

SCHOOL OF INFRASTRUCTURE

DEPARTMENT OF CIVIL ENGINEERING

Report on Hands on Training at EIE Laboratory, BSACIST

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1. PREAMBLE

The Hands-on Training Event on Strain Gauge, Load Cell, and Data Acquisition System was organized by Dr. P. Gajalakshmi, Professor, and Dr. N. S. Shafeer Ahamed, Assistant Professor (Selection Grade), Department of Civil Engineering, BSACIST, and conducted by Dr. H. Kareemullah, Assistant Professor (Senior Grade) from the Department of Electronics and Instrumentation Engineering. The session engaged 1st Year M.Tech Structural Engineering students as participants on November 26, 2025, following the laboratory schedule, at the Electronics and Instrumentation Engineering (EIE) Laboratory located at BSACIST in Chengalpattu, Tamil Nadu, India.

2. Introduction and Event Overview

This hands-on training session was conducted as part of the CEF 6103 – Experimental Methods and Techniques curriculum to provide students with practical exposure to instrumentation and sensor technology. The event focused on three fundamental components used extensively in structural health monitoring, material testing, and experimental analysis: strain gauges, load cells, and data acquisition (DAQ) systems.

2.1 Students Details

The following students attended the training program.

S.No.	RRN	Name of the Students
1.	251202601001	GURUPRASADH A
2.	251202601002	RAHINI D A
3.	251202601003	SHAMEER M

The training bridged the theoretical knowledge gained in classroom settings with real laboratory practice, enabling students to understand how mechanical deformation is converted into electrical signals for precise measurement and analysis. This practical exposure is critical for M.Tech Structural Engineering students as these instruments form the backbone of modern structural testing and monitoring experiments.

3. Event Objectives and Learning Outcomes

3.1 Intended Learning Objectives

The training session was designed with the following pedagogical objectives:

- Observe the correct installation and working principles of strain gauges and load cells in laboratory settings
- Gain hands-on knowledge of how strain gauges and load cells are calibrated to ensure accuracy and reliability in measurements
- Comprehend the fundamental relationship between strain, electrical resistance, and mechanical deformation in sensing elements
- Learn the principle and application of Wheatstone bridge circuits for measuring minute resistance changes that would otherwise be undetectable
- Understand the functioning of data acquisition systems for collecting, processing, conditioning, and storing experimental data in real time

3.2 Relevance to Course CEF 6103

The practical skills and theoretical understanding gained during this event directly support the course outcomes of CEF 6103 – Experimental Methods and Techniques:

- Students develop proficiency in selecting, installing, and operating appropriate instrumentation for structural experiments

- Practical experience with DAQ systems enables students to handle real experimental data, a critical skill for thesis work and research
- Understanding calibration procedures and measurement principles ensures students can design and execute high-quality experiments with reliable data
- These instrumentation skills are essential for pursuing research in structural health monitoring (SHM), material characterization, and non-destructive testing (NDT)

4. Event Activities and Demonstrations

4.1 Demonstration 1: Strain Gauge Principle and Calibration

Key Activity: Calibration of strain gauge instruments and setup of measurement systems

During this demonstration, students observed:

- How a strain gauge responds to mechanical deformation through resistance change
- The calibration procedure to establish the relationship between applied strain and electrical output
- Connection of strain gauges to a Wheatstone bridge circuit for signal amplification
- Real-time changes in strain readings as loads were applied to test specimens

4.2 Demonstration 2: Load Cell Working Principle

Key Activity: Demonstration of load cell mounting, calibration, and force measurement

Students were shown:

- Proper mounting techniques for load cells in structural testing frames
- The zero-adjustment and calibration process using standard weights
- How applied loads are converted to proportional electrical signals
- The linear output response characteristic of properly calibrated load cells

- Real-time force measurements during loading and unloading cycles

4.3 Demonstration 3: Data Acquisition System (DAQ) Operation

Key Activity: Understanding DAQ functionality in signal conditioning and data recording

The instructor explained and demonstrated:

- How DAQ systems interface with sensors (strain gauges and load cells)
- Signal conditioning processes: amplification, filtering, and bridge completion
- Analog-to-Digital Conversion (ADC) processes that transform sensor signals into digital data
- Real-time graphical display of experimental data
- Data storage and retrieval mechanisms using different memory types (buffer memory, EEPROM, flash memory)
- Memory access patterns (FIFO and FILO) used in DAQ systems for efficient data handling



Fig. 1 Calibration of Equipment's – Demonstration

5. Key Technical Concepts Delivered

5.1 Resistance-Based Measurement Principle

The training reinforced the fundamental principle that resistance of a conductor depends on its geometry (length and cross-sectional area). When structural elements deform under load, tensile deformation increases length and decreases area, resulting in increased resistance, while compressive deformation decreases length and increases area, leading to decreased resistance. This principle forms the foundation of all resistance-based strain measurement systems.

5.2 Wheatstone Bridge Circuit

Students learned that the Wheatstone bridge serves as the standard method for detecting minute resistance changes in strain gauges. The bridge remains balanced with zero output when no deformation occurs, but produces an output voltage proportional to deformation when strain gauges change resistance. This configuration amplifies the signal, enabling accurate measurement of even micro-level changes.

5.3 Load Cell Integration

The event clarified how load cells integrate strain gauge technology, with four strain gauges arranged inside a steel or aluminum cell body. These gauges connect in a Wheatstone bridge configuration for maximum sensitivity, providing a linear relationship between applied force and electrical output. Calibration using known weights establishes measurement accuracy.

5.4 Data Acquisition and Storage

Students gained practical understanding of modern DAQ systems, which enable real-time monitoring by continuously sampling sensor outputs. These systems perform essential signal processing through amplification and filtering to remove noise from signals, while converting analog inputs from sensors into digital values suitable for computer processing. Additionally, DAQ systems utilize multi-level storage solutions, including buffer memory,

EEPROM, flash memory, and hard disk, to meet diverse data retention needs across temporary, configuration, logging, and long-term analysis requirements.

6. Relevance to Course and Future Applications

6.1 Relevance to CEF 6103 Learning Outcomes

This hands-on training directly fulfills multiple learning outcomes of CEF 6103:

1. **Experimental Design Competency:** Students can now select appropriate instrumentation based on measurement requirements
2. **Hands-On Proficiency:** Practical experience reduces the learning curve for thesis work and independent research projects
3. **Data Integrity Understanding:** Knowledge of calibration and measurement principles ensures high-quality experimental data
4. **Industry-Ready Skills:** These skills align with industry practices in structural testing, material characterization, and quality control laboratories

6.2 Applications in Structural Engineering

The instrumentation knowledge acquired during this event will be directly applicable to:

- **Material Testing:** Measuring strain in concrete and steel samples during destructive and non-destructive tests
- **Structural Health Monitoring (SHM):** Long-term monitoring of building and bridge health using strain and load sensors
- **Non-Destructive Testing (NDT):** Indirect measurement of structural integrity without damaging test specimens
- **Research and Thesis Work:** Conducting independent experiments with reliable, calibrated instrumentation
- **Remedial Construction:** Assessing structural behavior before and after repair interventions

7. Conclusions and Recommendations

7.1 Event Summary

The hands-on training on strain gauges, load cells, and data acquisition systems was highly successful in bridging the gap between theoretical knowledge and practical laboratory skills. The event provided valuable, hands-on exposure to instrumentation that forms the foundation of modern structural engineering practice.

7.2 Learning Outcomes Achieved

By participating in this event, students have:

- Developed practical skills in sensor installation and calibration
- Gained insight into signal conditioning and data acquisition processes
- Understood the critical importance of measurement accuracy in experiments
- Connected course theory (CEF 6103) to real laboratory practice
- Built confidence in handling advanced instrumentation

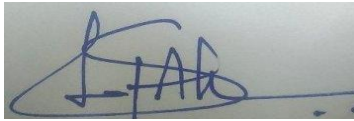
7.3 Recommendations for Future Practice

Students are encouraged to:

- Apply these skills in their upcoming thesis and research projects
- Revisit DAQ concepts when designing experiments requiring precise measurements
- Practice calibration procedures before conducting important experiments
- Document experimental procedures to ensure reproducibility and data quality
- Consider advanced training in specialized instrumentation for their research focus areas

7.4 Appreciation and Closure

We extend our sincere appreciation to Dr. H. Kareemullah for conducting this highly informative and well-organized training session. The practical demonstrations significantly enhanced students' understanding of instrumentation, measurement principles, and experimental methodology. This event will undoubtedly contribute to the success of students' academic research and professional careers in structural engineering.



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