



# SNS COLLEGE OF TECHNOLOGY

( An Autonomous Institution)

Coimbatore-35



DEPARTMENT OF BIOMEDICAL ENGINEERING

**23BMT203 - BIOMEDICAL TRANSDUCERS AND SENSORS**

**UNIT II- Pressure, Displacement and Temperature  
II Year/ IV Sem**

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## BIOMEDICAL TRANSDUCERS AND SENSORS



- ✓ Resistive Strain Gauges and Bridge circuit
- ✓ Piezoelectric Transducers
- ✓ Potentiometric Transducers
- ✓ Capacitive, Inductive
- ✓ LVDT Transducers - Principle
- ✓ Equivalent Circuit & Linearity Issues
- ✓ Thermo Resistive - Resistance Temperature Detectors (RTDS)
- ✓ Thermistor Thermo Electric - Thermocouple
- ✓ PN Junction Diode



# Piezoelectric Transducers



## **Definition**

A piezoelectric transducer converts mechanical energy (pressure, force, or vibration) into electrical energy using the piezoelectric effect.

## **Piezoelectric Effect**

Certain materials generate an electric charge when subjected to mechanical stress. This effect is reversible, meaning applying voltage can also cause deformation.

## **Working Principle**

When pressure or force is applied to a piezoelectric crystal, it generates a proportional voltage.

The generated voltage can be measured and used for sensing applications.

## **Signal Processing**

The output signal is often small and requires amplification and filtering.

Signal conditioning is needed for accurate measurement.



# Piezoelectric Transducers



## Types of Piezoelectric Transducers

Active: Generates electrical signals without an external power source (e.g., accelerometers).

Passive: Requires an external power source (e.g., ultrasonic sensors).

## Applications in Sensing

Measures pressure, force, and acceleration in various fields.

Used in industrial monitoring, biomedical devices, and aerospace.

## Applications in Actuation

Used in ultrasonic transducers, buzzers, and medical imaging (ultrasound machines).

Employed in precision motion control systems.

## Frequency Response

- Operates over a wide frequency range, making it ideal for dynamic force measurements.



# Piezoelectric Transducers



## **Sensitivity and Accuracy**

Highly sensitive to small forces.

Provides fast response times and accurate measurements.

## **Advantages**

Compact and lightweight

High sensitivity to force and pressure changes

No external power required for sensing

Durable and reliable in harsh environments

## **Disadvantages**

Cannot measure static forces effectively

Signal drift over time

Requires high-impedance circuitry for signal processing

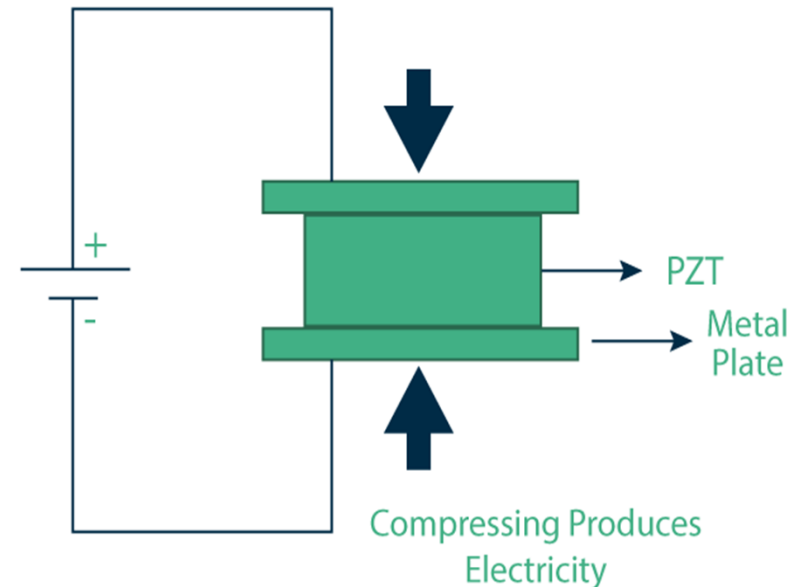


# Piezoelectric Transducers



## Working of Piezoelectric Transducer

- ✓ A piezoelectric transducer operates based on the piezoelectric effect, where mechanical stress generates an electrical charge in certain materials.
- ✓ A piezoelectric material, such as quartz, is coated with a thin conductive layer (e.g., silver) to facilitate charge collection.
- ✓ When stress is applied, the material's internal particles shift, creating an electric charge, whose polarity depends on the direction of the applied force—either compressive or tensile stress





# Piezoelectric Transducers



## **Applications:**

### **Structural Health Monitoring**

Detects vibrations and stress in bridges, aircraft, and industrial machinery.

### **Medical Applications**

Used in ultrasound imaging, pacemakers, and hearing aids.

### **Consumer Electronics**

Found in microphones, speakers, and touch sensors in smartphones.