

UNIT - III:

MOTION SENSORS



PSG College of
Technology, Coimbatore

SENSORS FOR ENGINEERING APPLICATIONS

23I202



Content of the Course – Sensors for Engineering applications 23I202

STRAIN AND PRESSURE MEASUREMENT	ELECTRONIC SENSORS	MOTION SENSORS	LIGHT SENSORS	THERMAL SENSORS
Resistance strain gauge Piezoelectric pressure sensor, characteristics Electronic circuits for strain gauge load cells Interferometer Capacitance pressure sensor	Inductive, Capacitive and ultrasonic based proximity sensors Reed switch Hall-effect switching sensors Capacitive based humidity sensor Liquid level detectors, Flow sensors Smoke sensors	Capacitor plate sensor Inductive sensors LVDT Accelerometer systems Rotation sensors Piezoelectric devices for motion sensing Hall effect-based speed sensor.	Color temperature Light flux Photo sensors, Photo resistor and photoconductors, Photodiodes, Phototransistors, Photovoltaic devices, Fiber-optic sensors (FOS): Fibre-optic pressure sensor and its applications	Bimetallic strip, Semiconductor based Temperature sensor, Thermocouples, Resistance thermometers, Thermistors, PTC and NTC thermistors Semiconductor-based applications. Infrared sensors: bolometer, Pyroelectric detector, semiconductor based IR sensors.



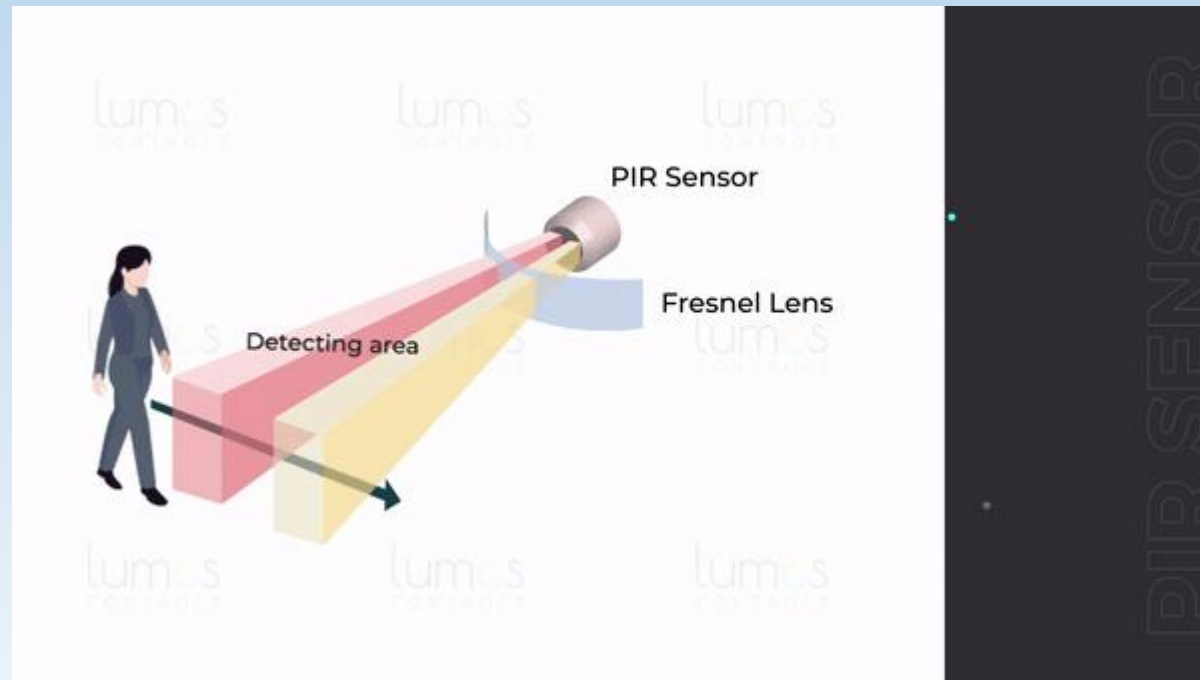
CONTENTS

UNIT - III

1. Capacitor plate sensor
2. Inductive sensors
3. LVDT Accelerometer systems
4. Rotation sensors
5. Piezoelectric devices for motion sensing
6. Hall effect-based speed sensor.

MOTION SENSOR

Motion sensors are devices that detect physical movement in a given area and convert it into an electrical signal.



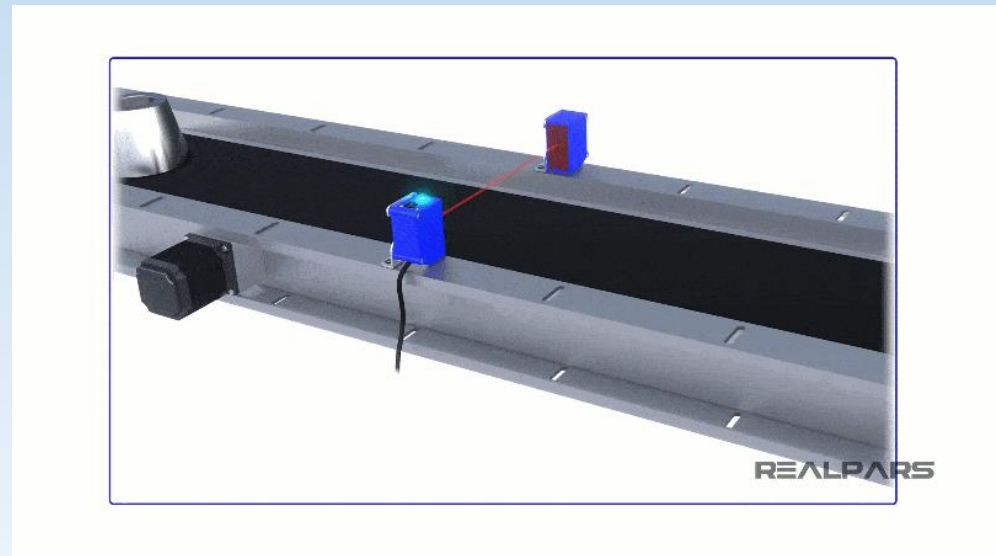
MOTION SENSOR

Motion sensors are devices that detect physical movement in a given area and convert it into an electrical signal.



MOTION SENSOR

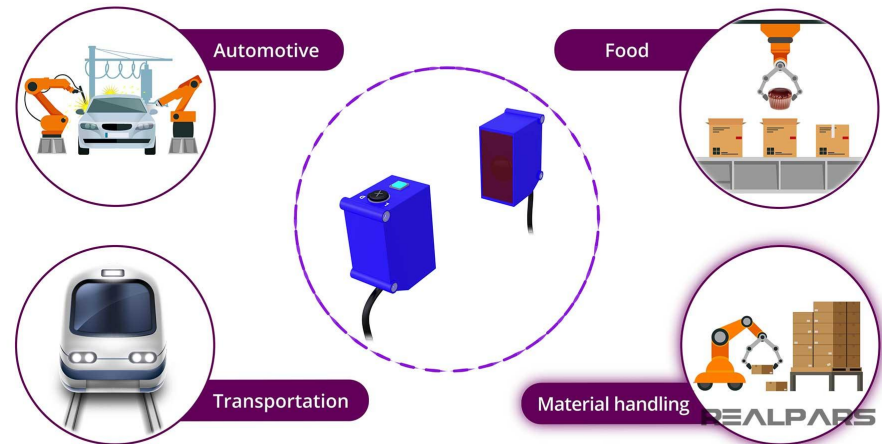
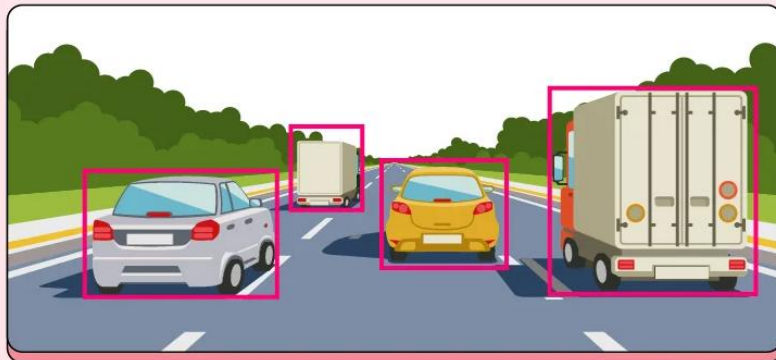
They're used in a wide range of applications—from security systems and smart lighting to robotics and gesture recognition.



MOTION SENSOR

They're used in a wide range of applications—from security systems and smart lighting to robotics and gesture recognition.

Object Detection and Tracking



MOTION SENSOR



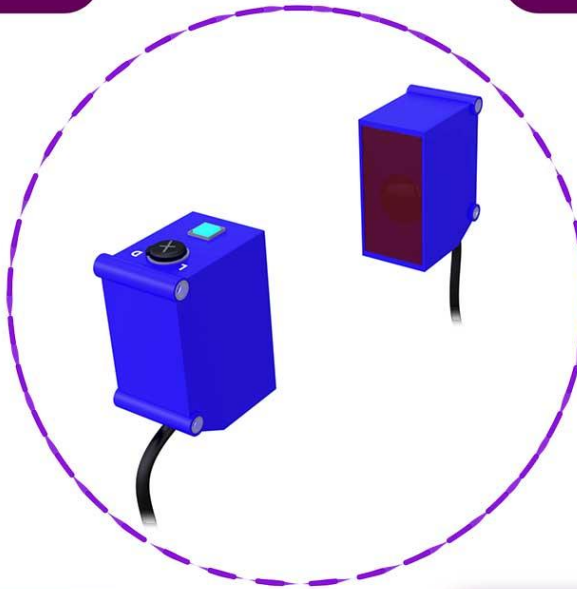
Automotive



Food



Transportation

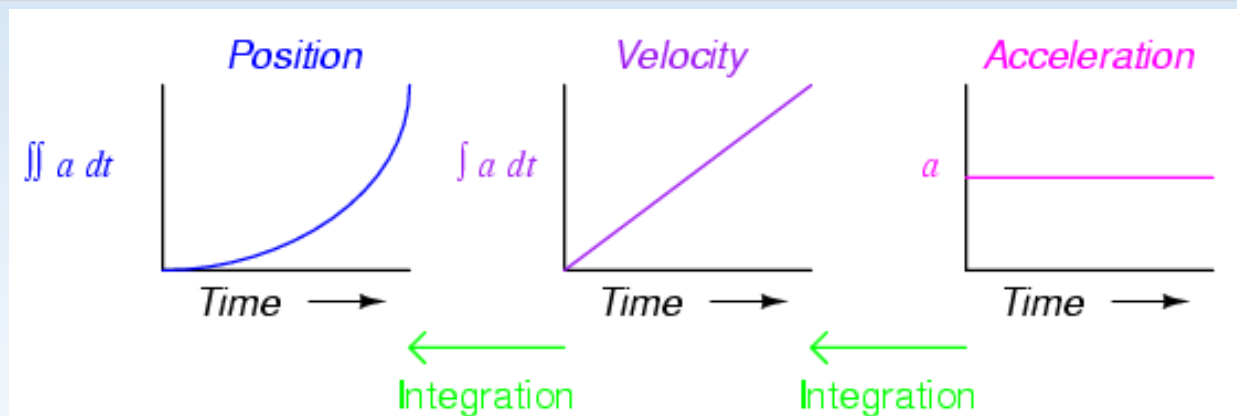
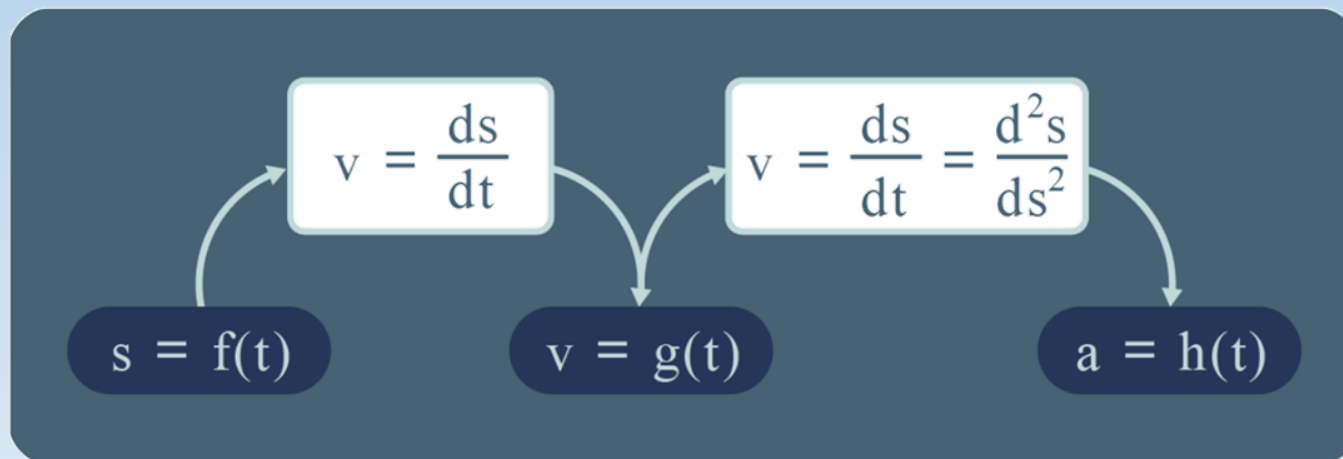


Material handling

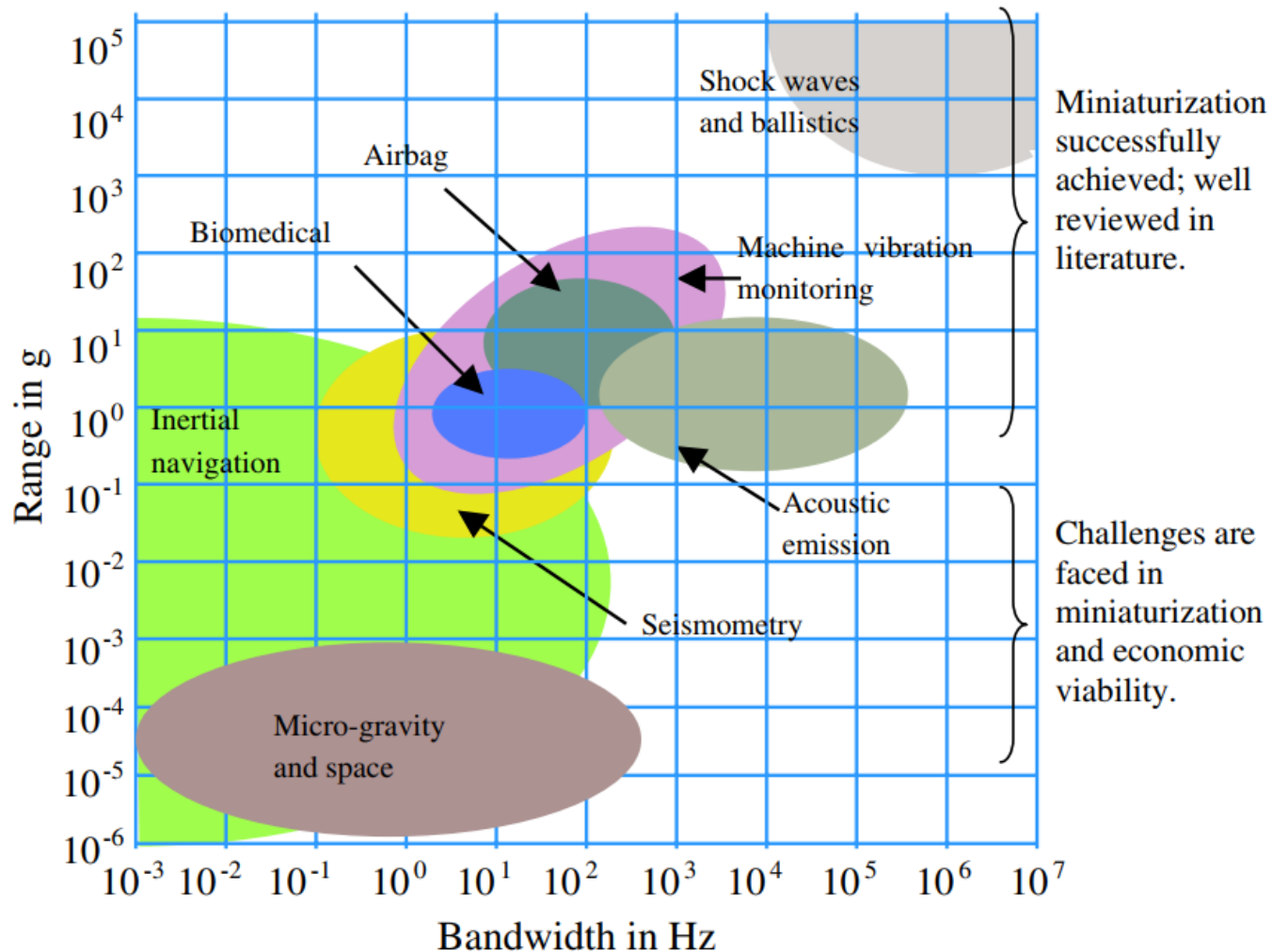


MOTION represents not only displacement

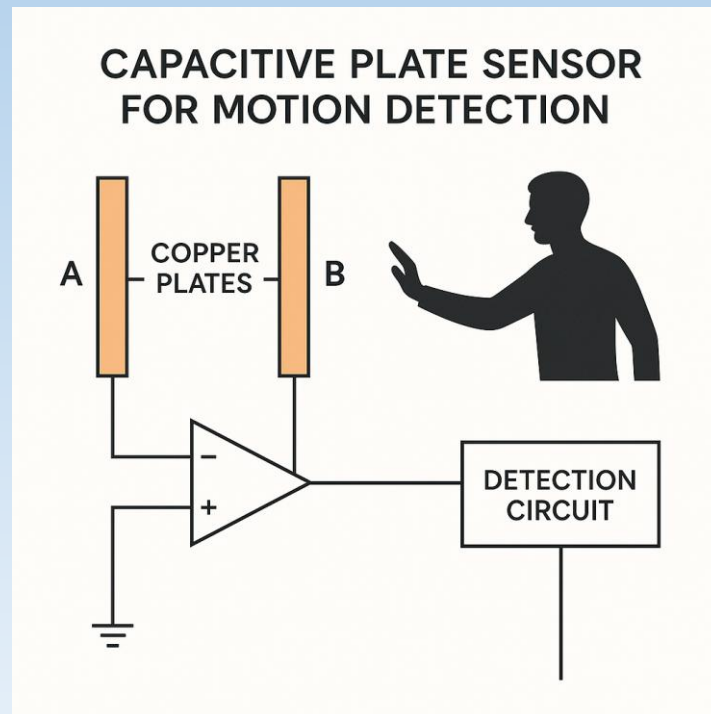
Relationship between Displacement Function, Velocity Function and Acceleration Function



Acceleration measurement



Capacitor plate sensor



A **capacitive plate sensor** for motion detection is a type of non-contact sensor

detects the presence or movement of an object (usually a human or a conductive material)

by measuring **changes in capacitance** between conductive plates or between a plate and the ground.

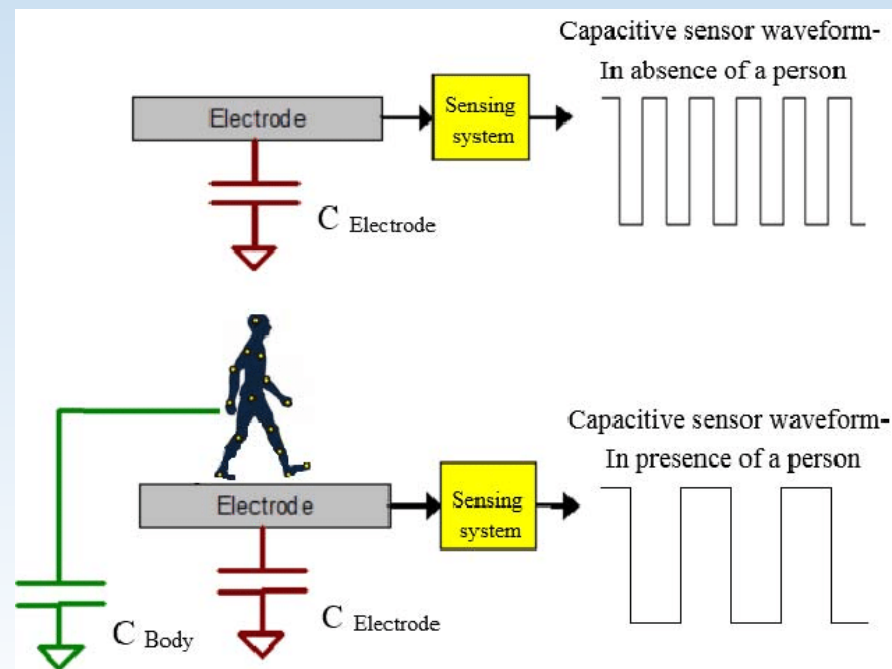
Capacitance C between two plates is given by:

$$C = \frac{\epsilon A}{d}$$

Capacitor plate sensor

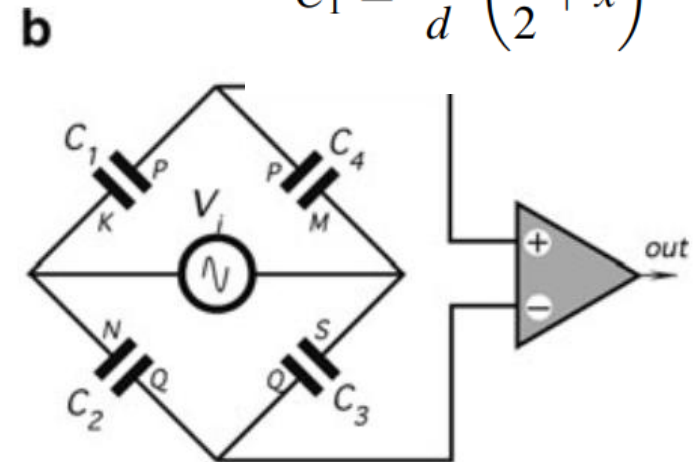
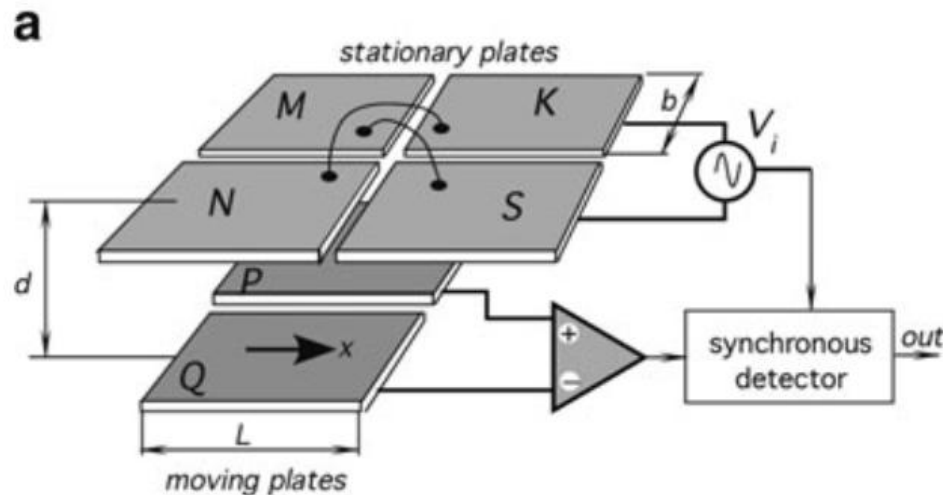
In a capacitive motion sensor:

- The sensor has one or more conductive plates.
- When a person or object moves near the sensor, the **effective dielectric environment changes** (e.g., due to the presence of the human body, which is conductive).
- This causes a **change in capacitance**, which is measured by the circuit.
- A change in capacitance indicates **motion or proximity**.



Capacitor plate sensor

In a capacitive motion sensor:



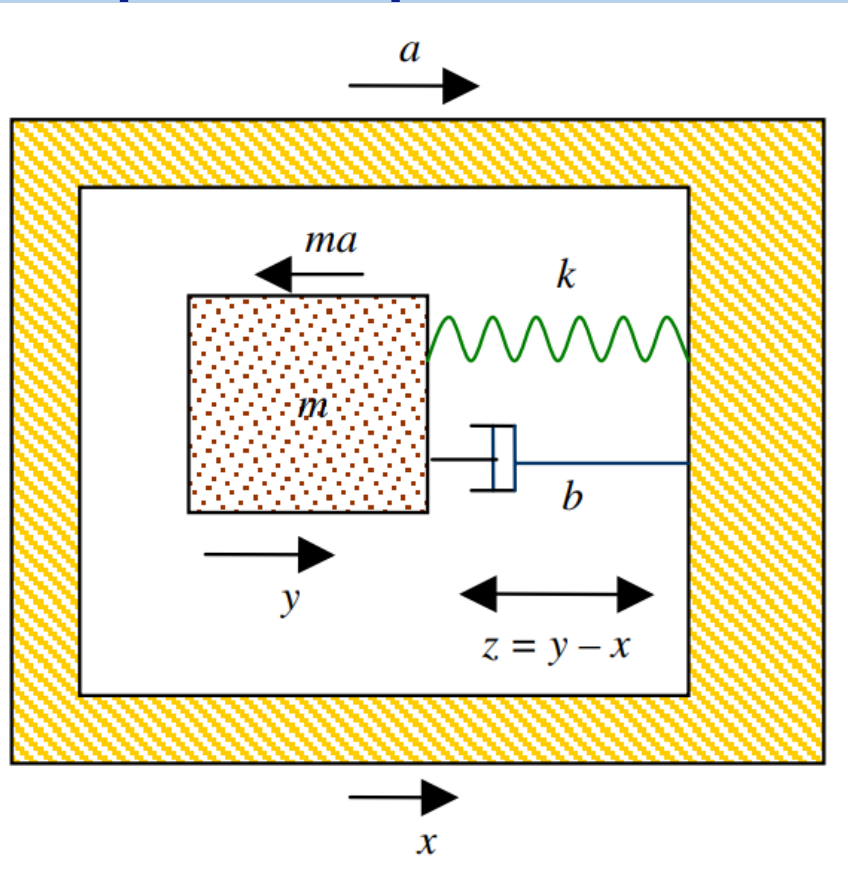
$$C_1 = \frac{\epsilon_0 b}{d} \left(\frac{L}{2} + x \right)$$

Fig. 7.10 Parallel-plate capacitive bridge sensor plate arrangement (a) and equivalent circuit diagram (b)

A bridge excitation source provides a sinusoidal voltage (5–50 kHz) and the voltage difference between the pair of moving plates is sensed by the differential amplifier whose output is connected to the input of a synchronous detector.

A mutual shift of the plates with respect to a fully symmetrical position results in the bridge disbalance and the phase-sensitive output of the differential amplifier.

Capacitor plate sensor



accelerometer comprises
a spring,
a damper,
a seismic mass, and a
displacement sensor arranged
within a housing attached to
a base as shown in **Figure** .

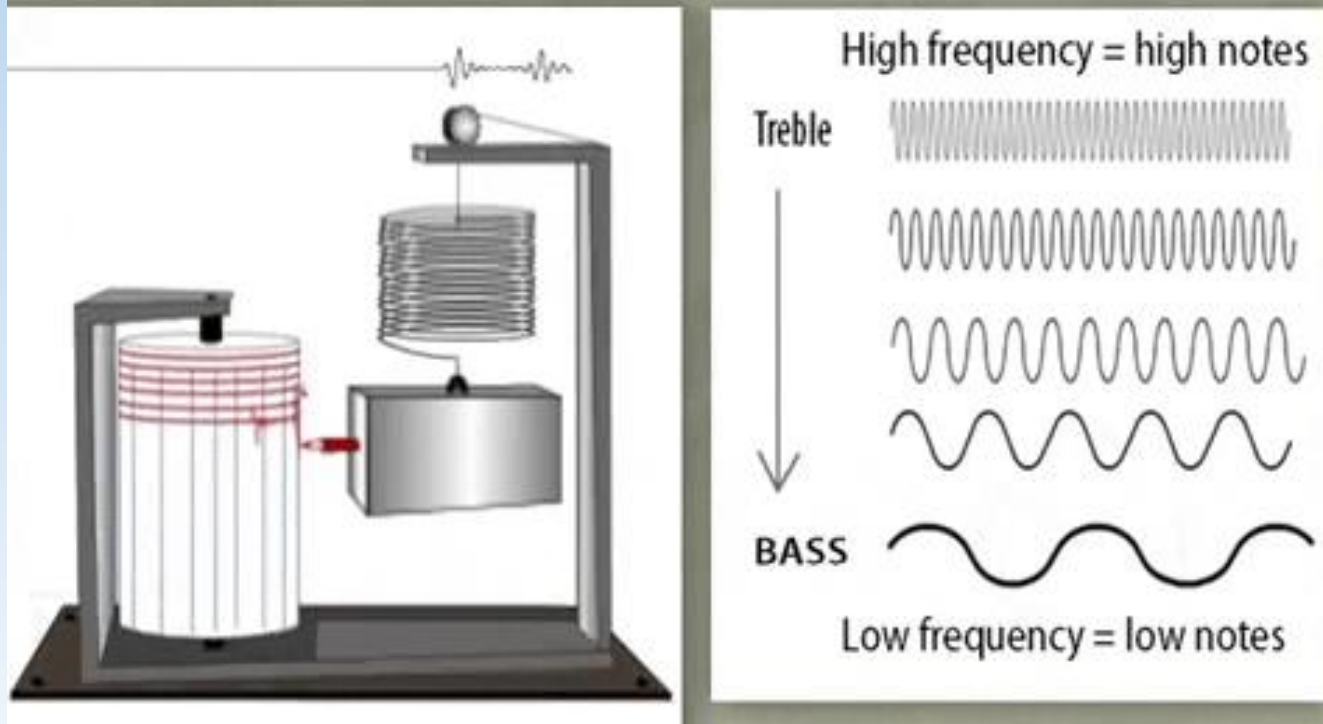
Seismic
Mass (m)

In operation, the base is mounted on the vibrating structure to be measured, and the relative displacement between the seismic mass and the base is recorded by the displacement sensor.

Air bag deployment in automobiles;
High-g accelerometers used for impact testing etc.

Capacitor plate sensor

The Richter scale is governed by **Amplitude** & **Distance**



Earthquake Monitoring

Inertial Navigation

Structural Health Monitoring

Vibration Isolation Systems

Fault Detection of Wind Turbine

Capacitor plate sensor

Types of Configurations:

1. Parallel Plate Configuration

Two conductive plates face each other; motion between or near the plates alters capacitance.

2. Single Plate with Ground Reference

More common in practical motion sensors. A single electrode measures capacitance between itself and the nearby human body (which acts as the other "plate").

