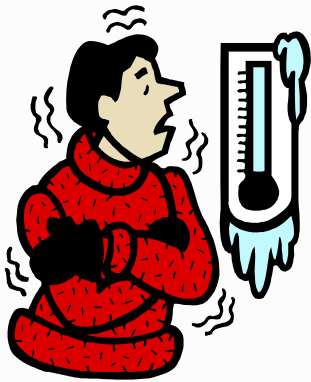
The logo of Galgotias University is a stylized circular emblem with three curved, overlapping bands in yellow, blue, and red, resembling a 'G' or a wave.

**Unit 1:  
L-6**

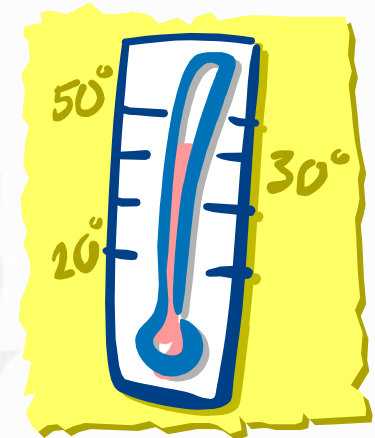
**Mechanical and Electromechanical sensor**

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By,  
Anurag Shanu



# Temperature Sensors



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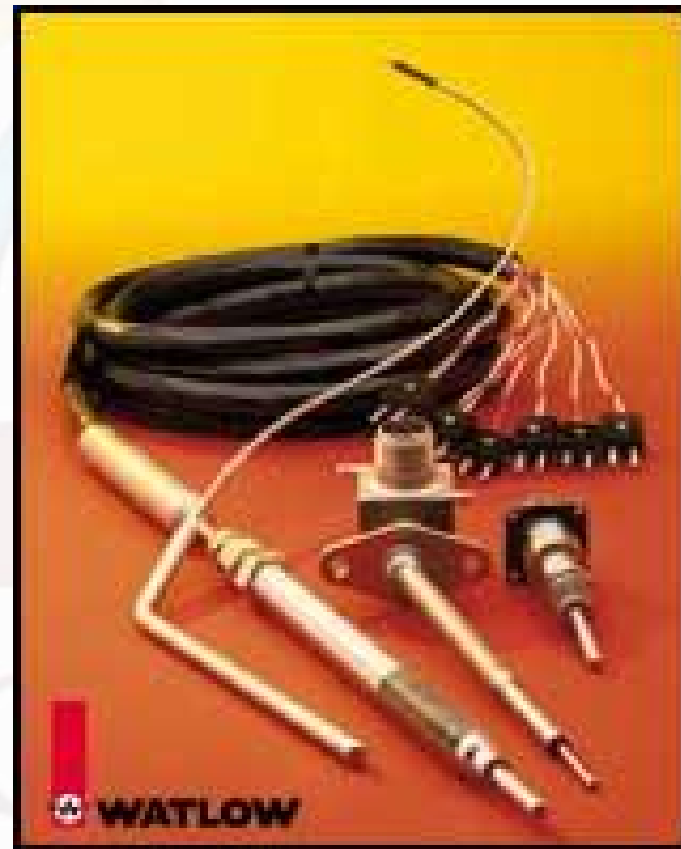
# Objectives

- Types of Sensors and how they work
- Sensor Applications
- Advantages and Disadvantages

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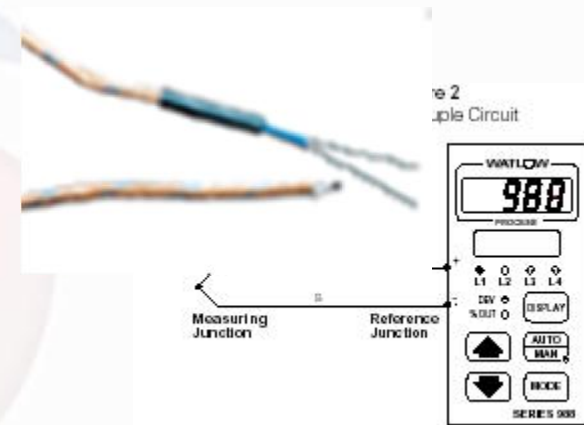
## Types of Temperature Sensors

- Thermocouples
- Resistance Temperature Detectors (RTDs)
- Thermistors
- Infrared Sensors
- Semiconductors



## Thermocouples

- Two wires of different metal alloys.
- Converts thermal energy into electrical energy.
- Requires a temperature difference between measuring junction and reference junction.
- Easy to use and obtain.



## Thermocouple Applications

- Plastic injection molding machinery
- Food processing equipment
- Semiconductor processing
- Heat treating
- Medical equipment
- Industrial heat treating
- Packaging equipment



# Thermocouples

## Advantages

- Simple, Rugged
- High temperature operation
- Low cost
- No resistance lead wire problems
- Point temperature sensing
- Fastest response to temperature changes

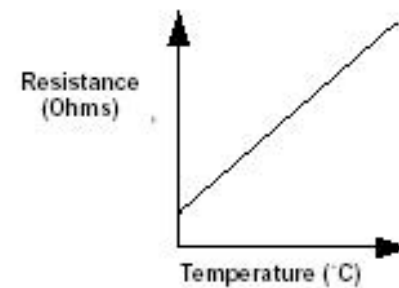
## Disadvantages

- Least stable, least repeatable
- Low sensitivity to small temperature changes
- Extension wire must be of the same thermocouple type
- Wire may pick up radiated electrical noise if not shielded
- Lowest accuracy

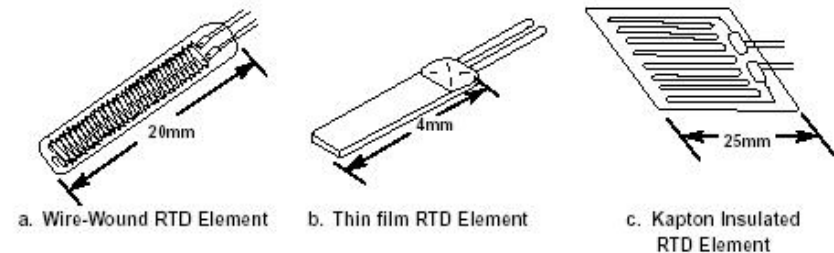
# Resistance Temperature Detectors (RTDs)

- Wire wound and thin film devices.
- Nearly linear over a wide range of temperatures.
- Can be made small enough to have response times of a fraction of a second.
- Require an electrical current to produce a voltage drop across the sensor

RTD Resistance Vs Temperature (TCR) Curve



Various RTD Element Styles





## RTD Applications

- Air conditioning and refrigeration servicing
- Furnace servicing
- Foodservice processing
- Medical research
- Textile production



## RTDs

### Advantages

- Most stable over time
- Most accurate
- Most repeatable temperature measurement
- Very resistant to contamination/
- corrosion of the RTD element

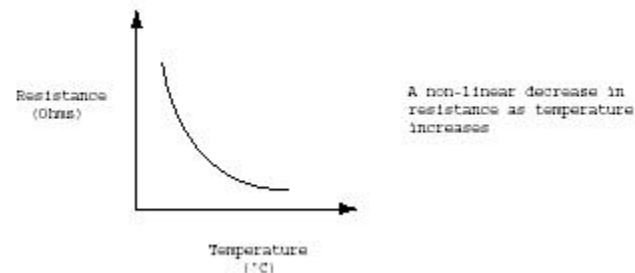
### Disadvantages

- High cost
- Slowest response time
- Low sensitivity to small temperature changes
- Sensitive to vibration (strains the platinum element wire)
- Decalibration if used beyond sensor's temperature ratings
- Somewhat fragile

## Thermistors

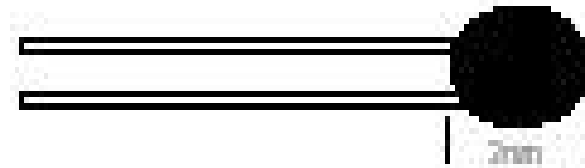
- A semiconductor used as a temperature sensor.
- Mixture of metal oxides pressed into a bead, wafer or other shape.
- Beads can be very small, less than 1 mm in some cases.
- The resistance decreases as temperature increases, negative temperature coefficient (NTC) thermistor.

Thermistor Resistance Vs Temperature Relationship (NTC)

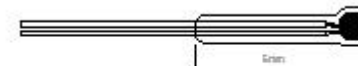


## Thermistors

- Most are seen in medical equipment markets.
- Thermistors are also used are for engine coolant, oil, and air temperature measurement in the transportation industry.



a. Epoxy Coated Thermistor Bead.



b. Glass Coated Thermistor Bead.

# Thermistors

## Advantages

- High sensitivity to small temperature changes
- Temperature measurements become more stable with use
- Copper or nickel extension wires can be used

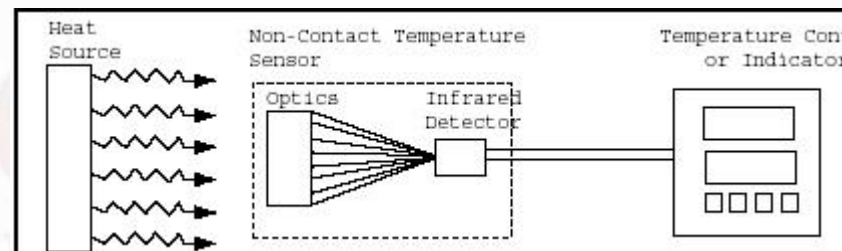
## Disadvantages

- Limited temperature range
- Fragile
- Some initial accuracy “drift”
- De-calibration if used beyond the sensor’s temperature ratings
- Lack of standards for replacement

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## Infrared Sensors

- An infrared sensor intercepts a portion of the infrared energy radiated by an object.
- Many types Optical Pyrometers, Radiation Pyrometers, Total Radiation Pyrometers, Automatic Infrared Thermometers, Ear Thermometers, Fiber optic Thermometers, Two-Color Pyrometers, Infra-Snakes, and many more.



# Infrared Applications

- Manufacturing process like metals, glass, cement, ceramics, semiconductors, plastics, paper, textiles, coatings.
- Automation and feedback control
- Improve safety in fire-fighting, rescues and detection of criminal activities.
- Used to monitor and measure human body temperatures with one second time response.
- Reliability and maintenance needs from building heating to electrical power generation and distribution



# Infrared Sensors

## Advantages

- No contact with the product required
- Response times as fast or faster than thermocouples
- No corrosion or oxidation to affect sensor accuracy
- Good stability over time
- High repeatability

## Disadvantages

- High initial cost
- More complex - support electronics required
- Emissivity variations affect temperature measurement accuracy
- Field of view and spot size may restrict sensor application
- Measuring accuracy affected by dust, smoke, background
- radiation, etc.



# Semiconductors

- Are small and result from the fact that semiconductor diodes have voltage-current characteristics that are temperature sensitive.
- Temperature measurement ranges that are small compared to thermocouples and RTDs, but can be quite accurate and inexpensive.

# Semiconductor Applications

- Hard Disk Drives
- Personal Computers
- Electronic Test Equipment
- Office Equipment
- Domestic Appliances
- Process Control
- Cellular Phones

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# Summary

- Sensors are used for many real life applications from basic household appliances to industrial purpose
- These are used for measurement of physical properties and convert it to some electrical signals

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