1 Formula

Gauge Factor

$$G.e = \frac{\Delta R}{R}$$

$$\frac{\Delta R}{R} = \frac{\Delta \rho}{\rho} + (1 + 2k)\frac{\Delta L}{L} = G.e$$

RTD(Resistance Temperature Device)

$$R_T = R_0(1 + a_1 T + a_2 T^2 + \cdots + a_n T^n)$$

$$\epsilon(T) = R(T) - R(ideal)$$

Thermistor

$$R = R_0 e^{\frac{1}{\beta}(\frac{1}{T} - \frac{1}{T_0})}$$

Hamming Code

$$2^r = n + 1$$

$$r = 3.322 log_2^n$$

Accelerometer

Steady-state sensitivity

$$S_0 = \frac{Steady\ state\ voltage}{acceleration}$$

Unit: $\frac{V}{g}$

First-order System

$$x(t) = x(\infty) + (x(0) - x(\infty))e^{-\frac{t}{\tau}}$$

Hamming Distance Between A and B

$$A \oplus B$$

2 Definition

- **Sensitivity**: Sensitivity if a measure of change in output of an instrument for a change in measurement input variable.
- **Rosulution**: Resolution is smallest increment of measurand, which can be measured by instruments.
- **Nonlinearity**: Nonlinearity is defined as maximum deviation of any of output readings from the approximate transfer function.
- **Hysteresis**: Hysteresis is the deviation of sensor's output at a specified point of input signal, when the input signal is approached from opposite direction, it is expressed as maximum hysteresis.
- **MEMS**: Micro-Electro-Mechanical Systems. Micro-components integrated on a single chip, which allows the micro-system to control the system.

3 Tao Lu

3.1 Transient Response Analysis

1. Find the point with proper $\frac{\omega}{\omega_n}$ and ζ
2. Read $\frac{S}{S_0}$ from the graph
3. Convert from dB, then find S
4. $V = S \times a$, where a is acceleration
5. $V_{p-p} = 2 \times V$

3.2 Thermalcouple

1. Denote the voltage with reference temperature T_1 is V_1
2. Find voltage at reference temperature V_2
3. The voltage with reference temperature 0 is $V = V_1 + V_2$
4. Find the temperature.

3.3 RTD(end point linearity)

1. Write down $R_T = R_0(1 + a_1T + a_2T^2 + \cdots + a_nT^n)$
2. Find R at T_{max}
3. Calculate the slope $\frac{T_{max}-T_{min}}{R_{max}-R_{min}}$
4. The slope is sensitivity.
5. $\epsilon(T) = R(T) - R(ideal)$
6. $\frac{d\epsilon(T)}{dT}$, find T_0
7. Find $\epsilon(T_0)$
8. $\epsilon(\%FSD) = \frac{\epsilon(T_0)}{R_{Max}-R_{Min}}$

3.4 Strain Gauge

- **Temperature Compensator**: Does not measure strain, use cross axis.
- **Amplifier**: $Gain = \frac{R_{Right}}{R_Left}$

3.5 Resistive Potentiometer

- **Error**: Caused by the resistance of potentiometer, or resistance of wires.

3.6 Fuel Tank

Capacitance change when dielectric constant changes. The reading is not affected by the movement because the capacitors are connected in parallel, the total C does not change.

3.7 Accelerometer

Advantages of Servo Accelerometers

- Electronically control damping and spring coefficient, easy to get desired characteristics
- Low Hysteresis.

3.8 Noise Elimination

- **Capacitive**:
  1. Differential Amplifier
  2. Connect the inner conductor to outer conductor which is grounded
- **Electromagnatic**:
  1. Twist the conductors(cancel induced voltage).
  2. Physical seperation.
- **Ground Loops**:
  1. Remove one of the ground paths, thus converting the system to a single point ground.
  2. Isolate one of the ground paths with an isolation transformer, common mode choke, optical coupler, balanced circuitry, or frequency selective grounding.

3.9 Relative Error

1. Find the variable X.
2. Find the error may occur ΔX
3. Relative error is given by $\frac{\Delta X}{X}$