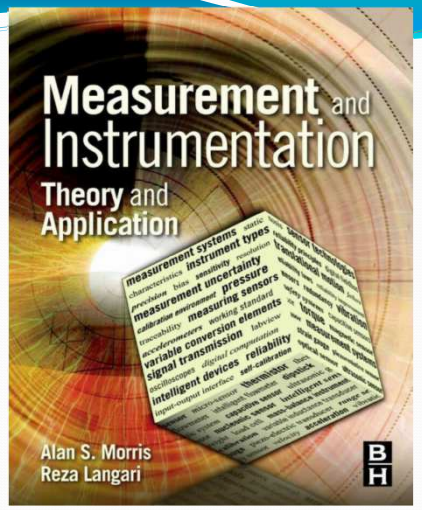
Principle of Measurements

School of Mechanical Engineering

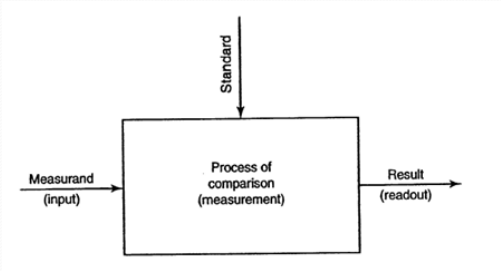
Measurement and Instrumentations

- Measurement is the assignment of a number to a characteristic of an object or event, which can be compared with other objects or events.
- A measuring instrument is a device for measuring a physical quantity. In the physical sciences, quality assurance, and engineering, measurement is the activity of obtaining and comparing physical quantities of real-world objects and events.

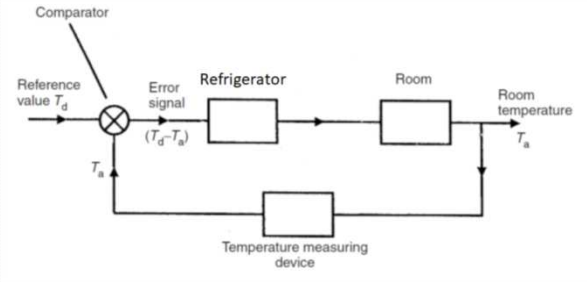
What is measurement?



Process of Measurement

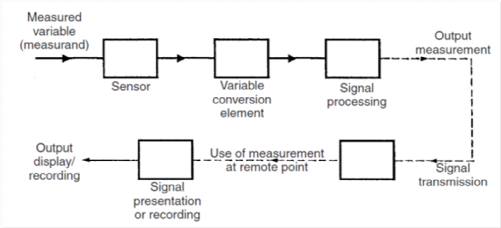


Measurement System Applications

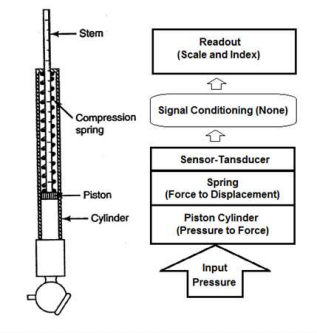


Stage of Measurement

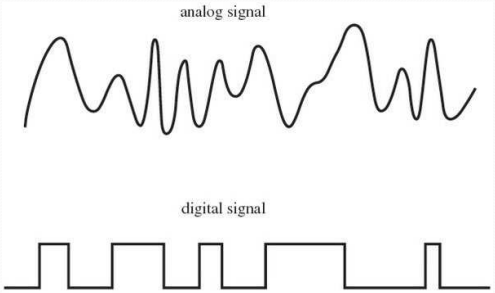
- Stage 1-sensor-transducer stage
- Stage 2-signal-conditioning stage
- Stage 3 readout-recording stage



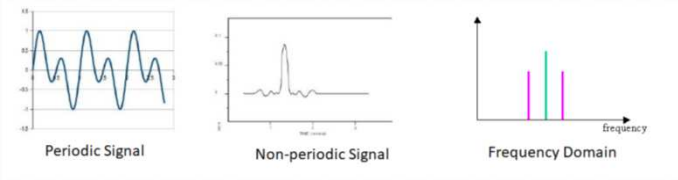
Example



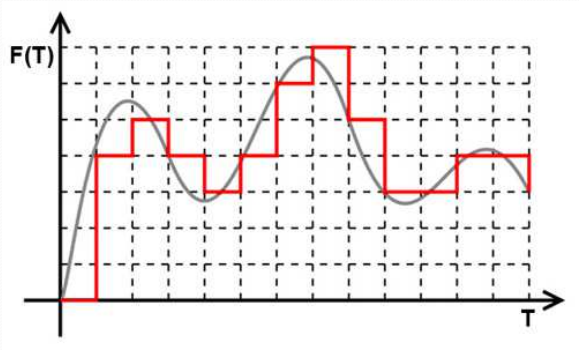
Type of Signal



Type of analog signal

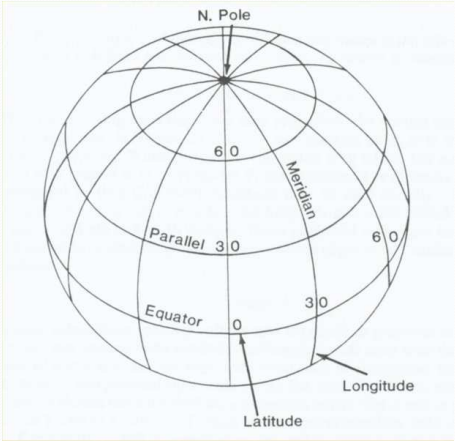


A/D Converter



Measurement Standard

(a) Fundamental Units		
Quantity	**Standard Unit**	**Symbol**
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Luminous	candela	cd
Matter	mole	mol
(b) Supplementary Fundamental Units		
Quantity	**Standard Unit**	**Symbol**
Plane angle	radian	rad
Solid angle	steradian	sr



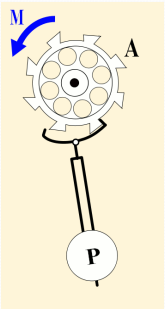
Length of 1 Meter

- The meter was originally defined in 1793 as one ten-millionth of the distance from the equator to the North Pole.

Basis of definition	Date	Absolute uncertainty	Relative uncertainty
$1/10{,}000{,}000$ part of the quarter of a meridian, astronomical measure by Bessel (443.44 lines)	1792	0.5–0.1 mm	10^{-4}
$1/10{,}000{,}000$ part of the quarter of a meridian, measurement by Delambre and Mechain (443.296 lines)	1795	0.5–0.1 mm	10^{-4}
First prototype *Metre des Archives* platinum bar standard	1799	0.05–0.01 mm	10^{-5}
Platinum-iridium bar at melting point of ice (1st CGPM)	1889	0.2–0.1 µm	10^{-7}
Platinum-iridium bar at melting point of ice, atmospheric pressure, supported by two rollers (7th CGPM)	1927	n.a.	n.a.
Hyperfine atomic transition; 1,650,763.73 wavelengths of light from a specified transition in krypton-86 (11th CGPM)	1960	0.01–0.005 µm	10^{-8}
Length of the path travelled by light in a vacuum in $1/299{,}792{,}458$ of a second (17th CGPM)	1983	0.1 nm	10^{-10}

One second

- The second is the SI base unit of time, commonly understood and historically defined as 1/86400 of a day.



Problems

1. How have systems of measurement units evolved over the years?
2. What are the main elements in a measurement system and what are their functions? Which elements are not needed in some measurement systems and why are they not needed?
3. What are the main factors governing the choice of a measuring instrument for a given application?
4. Name and discuss three application areas for measurement systems.