# Al-Mustaqbal University College
# Biomedical Engineering Department

*Subject:* Biomedical Instrumentation Design.

*Class (code):* 4th (BME416)

*Lecture:* *3*

BME416

## Biomedical Instrumentation Design

- Generalized Static Characteristics
- Quantitative criteria for the performance of instruments are needed to enable purchasers to compare commercially available instruments and evaluate new instrument designs.
- These criteria must clearly specify how well an instrument measures the desired input and how much the output depends on interfering and modifying inputs.
- Static characteristics describe the performance of instruments for dc or very low-frequency inputs.
- The properties of the output for a wide range of constant inputs demonstrate the quality of the measurement, including non-linear and statistical effects.

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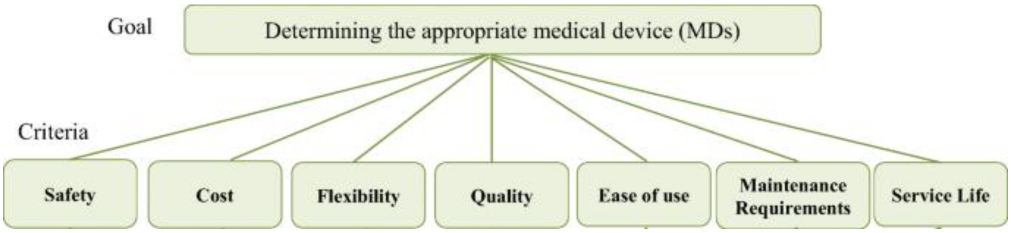
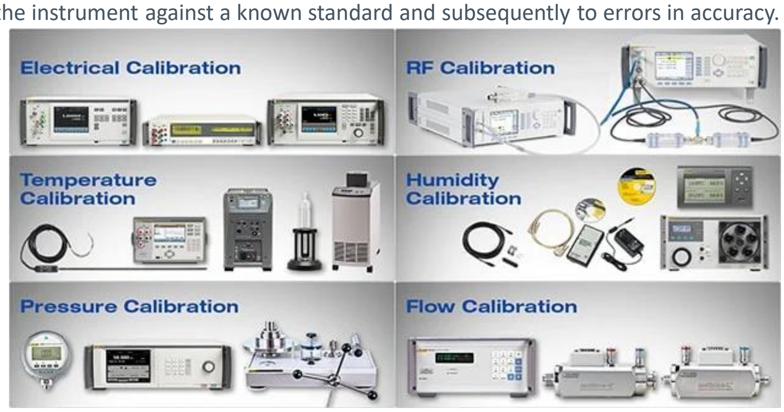
# Biomedical Instrumentation Design






# Biomedical Instrumentation Design

- Static Calibration
- The static performance characteristics are obtained in one form or another by a process.
- The calibration procedures involve a comparison of the particular characteristic with either a primary standard, a secondary standard with higher accuracy than the instrument to be calibrated, or an instrument of known accuracy.
- It checks the instrument against a known standard and subsequently to errors in accuracy.



# Biomedical Instrumentation Design

- Scale range and scale span
- Range of instrument: the region between the limits within which an instrument is designed to operate for measuring, indicating, or recording a physical quantity.
- The Scale Range of an instrument is the difference between the largest and the smallest reading of the instrument.
- The span is the difference between the highest and the lowest point of calibration.
- *For example*, for a thermometer calibrated between 30°C to 40°C,

➢ The range is 30°C to 40°C.

➢ The span is 40 - 30 = 10°C.

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# Biomedical Instrumentation Design

- ACCURACY
- The accuracy of a single measured quantity is the difference between the true value and the measured value divided by the true value.

$$Accuracy = \frac{True\ value - Measured\ Value}{True\ Value}$$

- This ratio is usually expressed as a percent, like percent of reading, percent of full scale, ± number of digits for digital readouts, or ± 1/2 the smallest division on an analog scale.
- For example, a converter may be termed 12-bit accurate if its error is 1 part in 4096.
- The sources of error contributing to the inaccuracy of a converter or linearly, gain, error, and offset
- error.
- If accuracy is expressed simply as a percentage, full scale is usually assumed.

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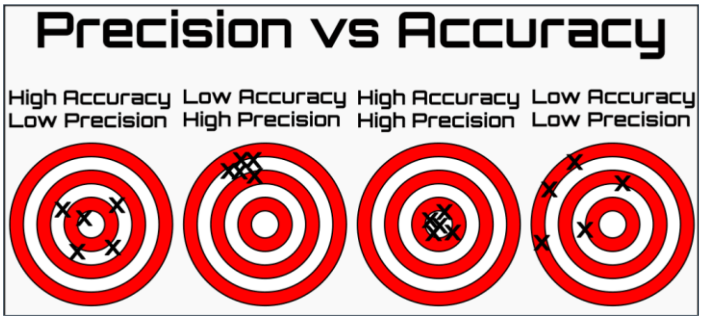
# Biomedical Instrumentation Design

- PRECISION
- The precision of a measurement expresses the number of distinguishable alternatives from which a given result is selected.
- For example, a meter that displays a reading of 2.434V is more precise than one that displays a reading of
- 2.43V. High-precision measurements do not imply high accuracy, however,
- because precision makes no comparison to the true value.

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# Biomedical Instrumentation Design

- RESOLUTION
- Resolution is the smallest incremental quantity that can be measured with certainty.
- Or: the smallest increment of measurement, movement, or other output that a machine, instrument, or component is capable of making.
- If the measured quantity starts from zero, the term threshold is synonymous with resolution.
- Resolution expresses the degree to which nearly equal values of a quantity can be discriminated.
- The car's speedometer, with 20Km/h subdivisions is an example of resolution.
- The resolution of the A/D converter is a measure of the number of discrete digital code that it can handle and is expressed as number of bits (binary).
- For example, for an 8-bit converter, the resolution is 1 part in 256.

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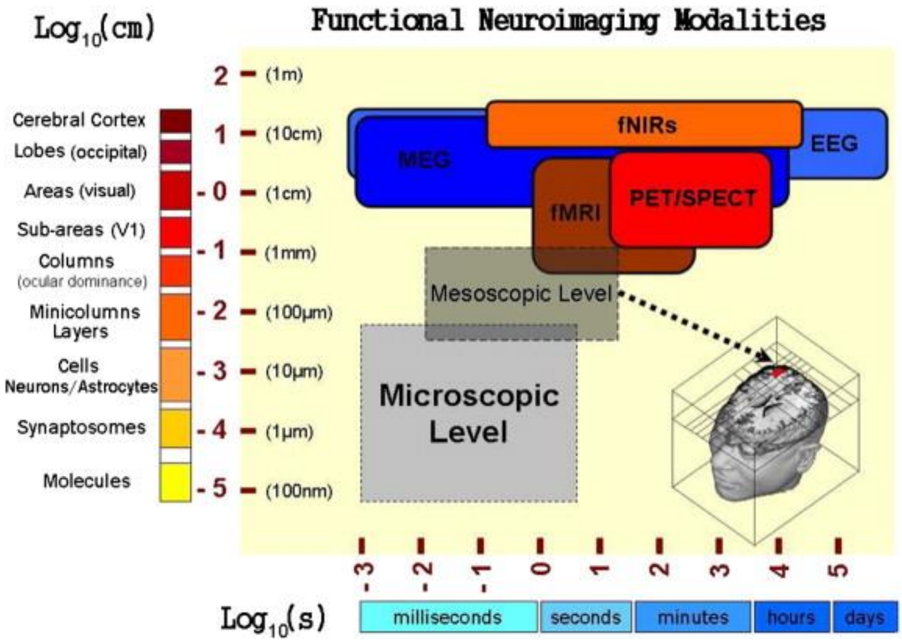
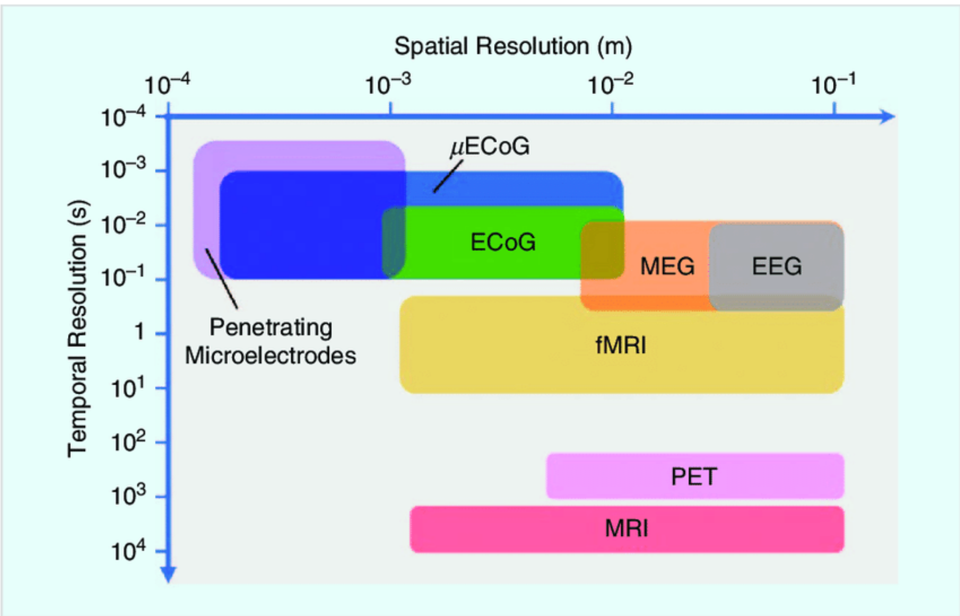
## Biomedical Instrumentation Design






## Biomedical Instrumentation Design



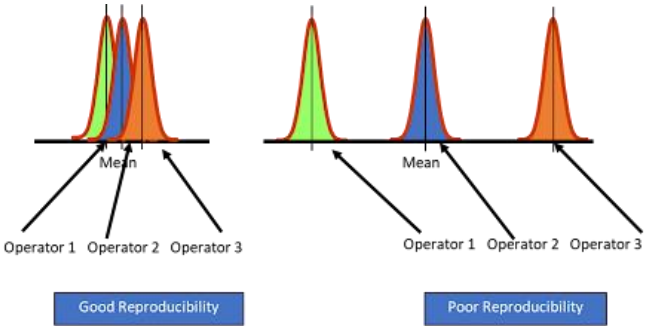
# Biomedical Instrumentation Design

› REPRODUCIBILITY

› The ability of an instrument to give the same output for equal inputs applied over some period of time. It is the closeness of output readings when the same input is applied repetitively over a short period of time.

› The measurement is made on the same instrument, at the same location, by the same observer and under the same measurement conditions.

› Perfect reproducibility means that the instrument has no drift.

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# Biomedical Instrumentation Design

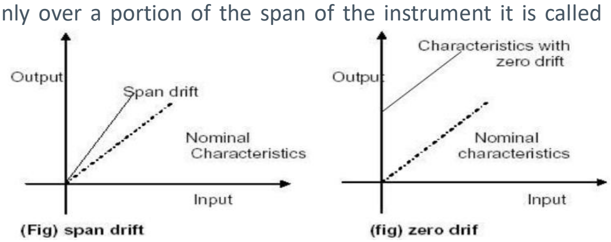
› Drift

› Drift is a departure in the output of the instrument over a period of time.

› An instrument is said to have no drift if it produces the same reading at different times for the same variation in the measured variable.

› Drift may be of any of the following types;

- a) Zero drift: Drift is called zero drift if the whole instrument calibration shifts over by the same amount.
- b) Span drift: If the calibration from zero upwards changes proportionately, it is called span drift. It may be due to the change in the spring gradient.
- c) Zonal drift: When the drift occurs only over a portion of the span of the instrument it is called zonal drift.

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