Tishk International University/Sulaimani
Faculty of Engineering
Civil Department

Surveying I

TOPIC: Surveying and Some Terms

2nd stage – Fall semester – 1st Lecture

Instructor:

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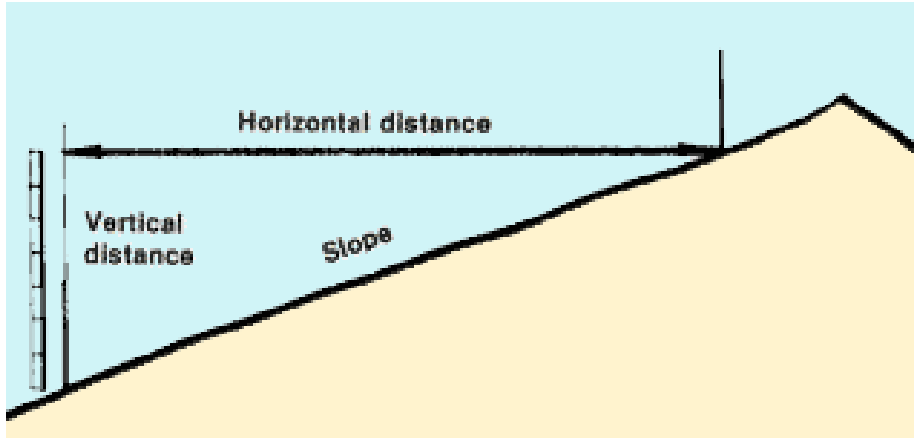
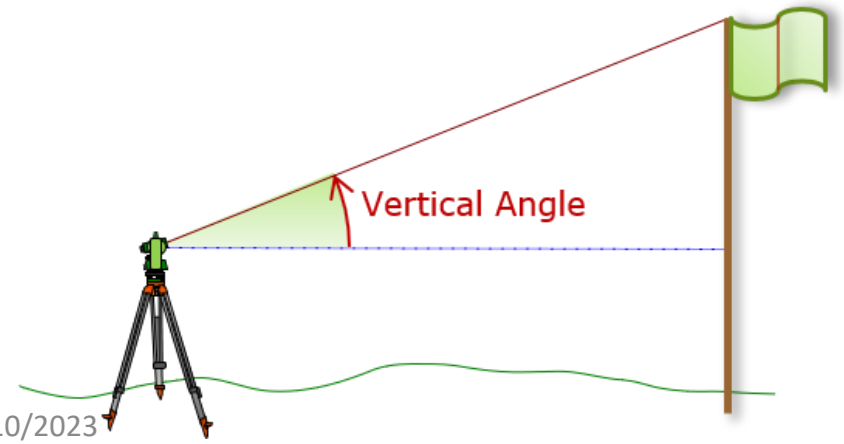
What is Surveying?

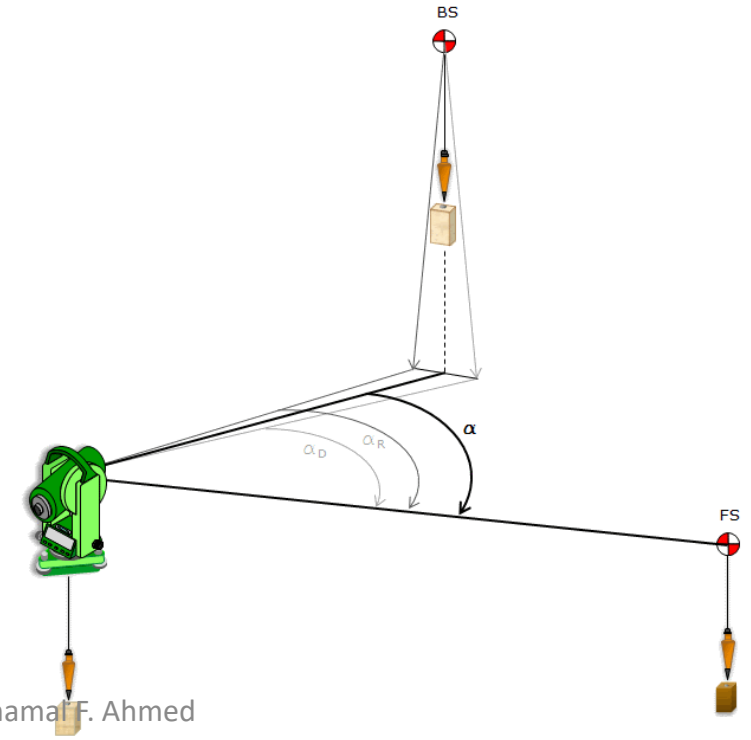
- Surveying is the art and science of taking field measurements on or near the surface of the Earth.
- Surveying may be defined as the science of determining the position, in three dimensions, of natural and man-made features on or near the surface of the Earth.

- Survey field measurements include:
  - horizontal and slope distances, vertical distances,



  - horizontal and vertical angles.





Observables:

- An observable is a quantity that can be measured in surveying.
- E.g. slope or horizontal distance, horizontal direction (or angle), vertical (or zenith) angle, azimuth (or bearing), elevation difference, relative gravity value, and coordinate difference.
- For example, if the distances AB, BD, DC, and CA, for a rectangle ABDC, are to be measured, then there are four distance observables AB, BD, DC, and CA. If the observable AB, for example, is measured three times, there will be three observations for one observable AB.

Observations:

- Observation (or measurement) is a numerical value assigned to an observable. This should not be confused with the elements (observables) that are to be measured.
- Note: The term observation or measurement is considered the same in this course.

❖Some facts about (Observation) Measurements:

❑No measurement is exact,

❑The true value of a measurement is never known, and

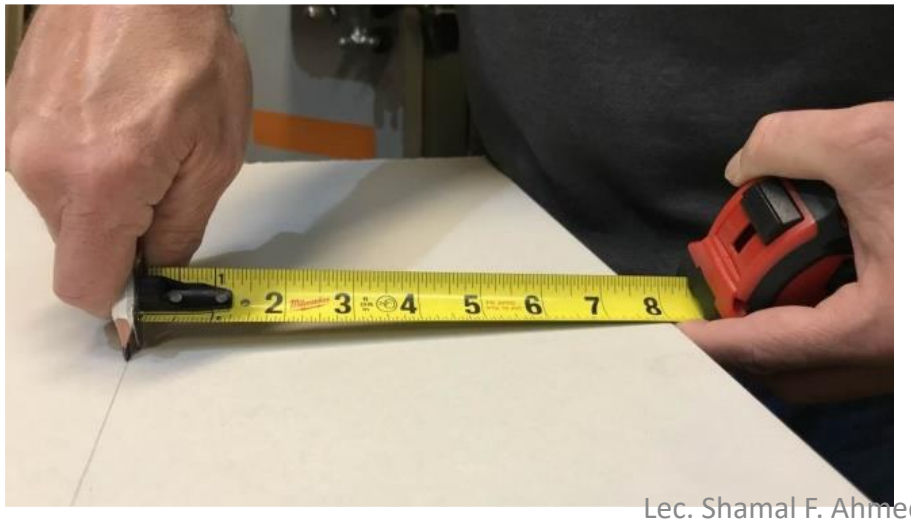
❑The amount of the errors present is always unknown.

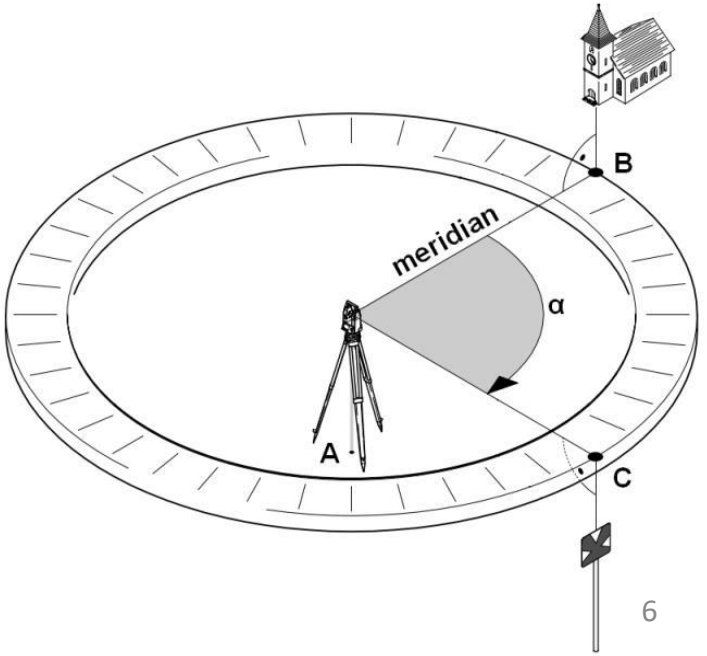
Direct and Indirect Measurements:

Direct measurements are made by applying an instrument directly to the unknown quantity and observing its value.

Example:

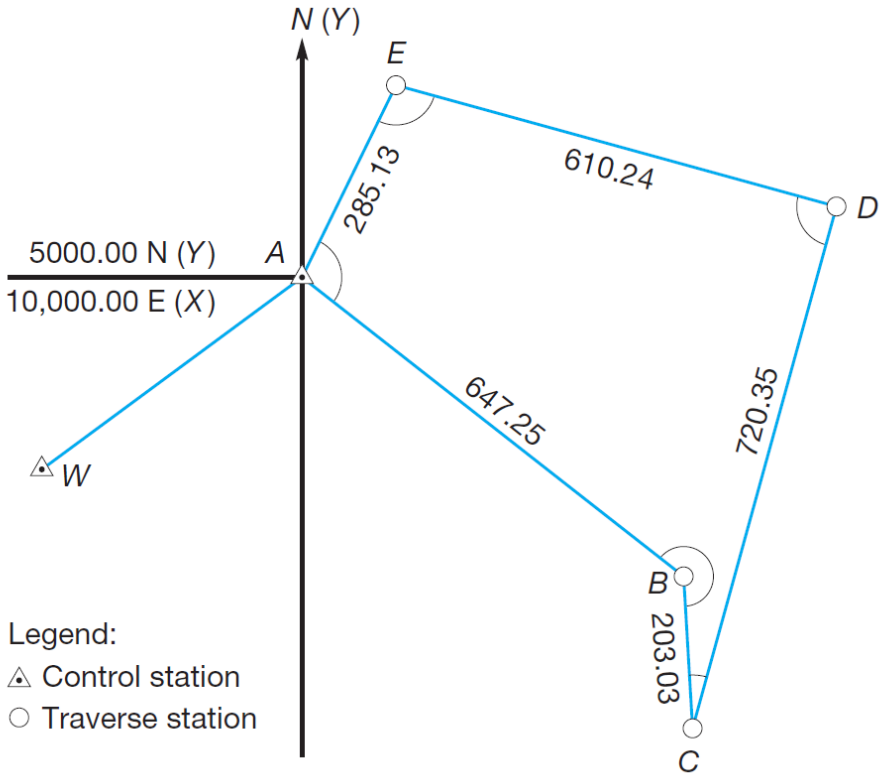
- Determining the distance between two points by making a direct measurement using a graduated tape, or measuring an angle by making a direct observation from the graduated circle of a total station instrument.





Indirect Measurements:

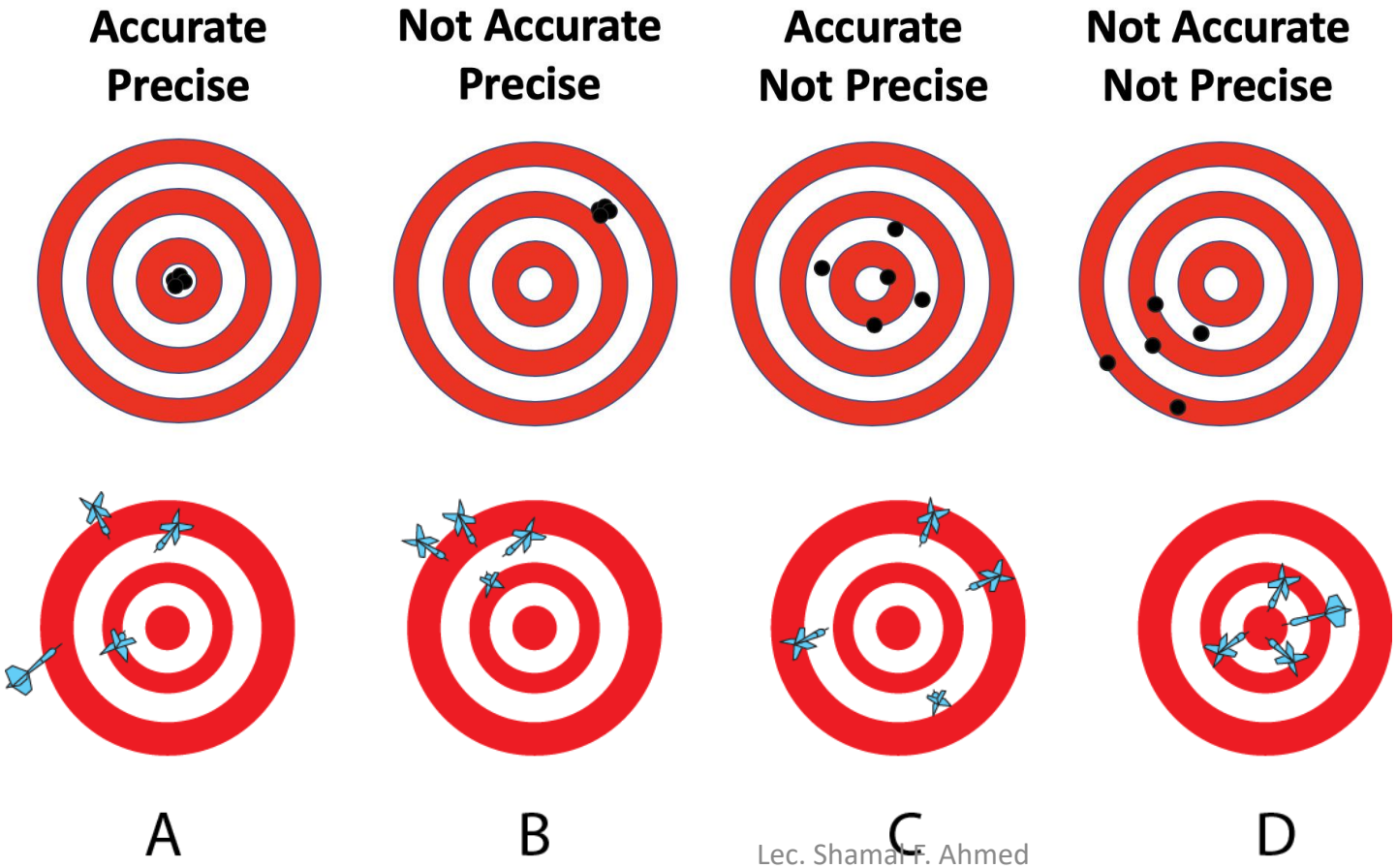
- Indirect measurements are obtained when it is not possible or practical to make direct measurements. In such cases the quantity desired is determined from its mathematical relationship to direct measurements.
- For example, computing coordinates from measured angles and distances between points.
- During this procedure, the errors that were present in the original direct observations are propagated (distributed) by the computational process into the indirect values.
- Thus, the indirect measurements (computed station coordinates, distances, directions, and angles) contain errors that are functions of the original errors. This distribution of errors is known as error propagation.



Precision and Accuracy:

Accuracy: refers to the degree of closeness of an estimate to its true value.

Precision: refers to the degree of closeness of an observation to its mean.



Example

- Two observations of a distance with a tape assumed to be 100.000 m long, that is actually 100.050 m, might give results of 453.270 and 453.272 m. These values are precise, but they are not accurate, since there is a systematic error.

The degree of precision attainable is dependent on:

- The stability of the environment during the time of measurement,
- The quality of the equipment used to make the observations, and
- The Observer's skill with the equipment and observational procedures.

Sources of error:

- **Instrumental error;**
- These errors are caused by imperfections in instrument construction or adjustment. For example:
- **In tape:** A tape may differ in actual length from its nominal graduated length because of a defect in manufacture or repair.
- **In level:** Testing and Adjusting the Line of Sight, Adjustment of the Horizontal Cross-Hair, and Testing and Adjusting Level Vials.

- **Natural error;**
- These errors are caused by changing conditions in the surrounding environment. These include variations in atmospheric pressure, temperature, wind, gravitational fields, and magnetic fields.
- The total station and EDM distance measurements are also refracted away from their ideal paths.

- **Personal error;**
- These errors arise due to limitations in human senses,
- such as the ability to center a level bubble.

Types of error:

- Systematic error
- Random error

Systematic error

- A *systematic* (or *cumulative*) error is the type of error that, remains the same as to sign and magnitude.
- Caused by; some persistent cause generally in an instrument, but sometimes in a habit of the observer.
- For Example; if a steel tape is 0.10 m too short, each time the tape is used, the same error is made. If the full tape length is used 10 times, the error accumulates and totals 10 times the error for one measurement.
- Elimination; by using some mathematical models to calculate appropriate corrections to measurements.

Random error

- A *random* (also known as *accidental*) error is a type of error whose magnitude and direction are just by accident and are beyond the control of the surveyor. They are generally small and are as likely to be negative as positive.

- Caused by; imperfections in measurement systems (people, instruments, and nature), random errors are unavoidable.

For Example; bubble not centered at the instant a levelling rod is read,

Elimination; They cannot be mathematically modeled, but are known to follow statistical laws of probability (adjustment), and they can be controlled, minimized, investigated, and estimated, but never eliminated.