

CVEN303 ENGINEERING MEASUREMENT

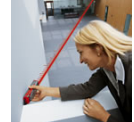
LECTURE 5 – ELECTRONIC DISTANCE MEASURING INSTRUMENTS
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(Sections 3.18 through 3.24)

Developed by Nasir G. Gharaibeh, Ph.D., P.E.
Zachry Department of Civil Engineering
Texas A&M University

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EDM Instruments

- EDM as a component of a total station (laser light or infrared light)
- Handheld laser EDM (no reflector is used)



Laser Distance Measurement Meter

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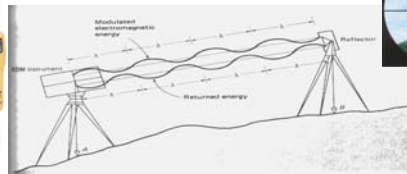
Types of EDM Instruments

- Handheld laser
 - <200m
- Light waves (laser or infrared)
 - Short range (0.5-3km); Medium range (3-10km); Long range (10-20 km)
- Microwave
 - Typical range ~50 km
 - Requires two identical EDM units at the two ends of the line.
 - Not common anymore. Replaced by GPS.

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How Do Light Wave EDMs Work?

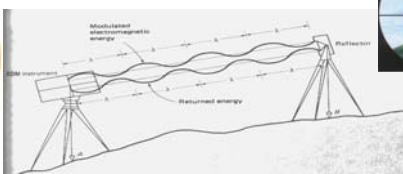
- EDM instrument sends a laser light or infrared light beam to a prism .
- The signal is reflected by a prism at the other end of the line back to the instrument. (The prism is designed so that the light is reflected back in the exact opposite direction.)



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How Do Light Wave EDMs Work? (cont.)

- Can we directly measure the time interval that passes while the light beam travels and then calculate distance as a multiplication of speed and time?
- How much is the speed of light in vacuum?
- EDMs get around this problem using wave theory.



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Scientific Principle of EDM – Wave Theory

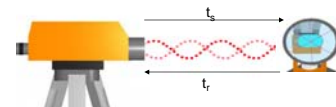
$$\lambda = \frac{c}{f}$$

Wave length, meter Velocity, meter/sec Frequency, Hz (cycle/sec)

$$L = \frac{n\lambda + \phi}{2}$$

Number of waves Distance, meter Partial wave length, meter

Several λ s are used iteratively to determine n and then L.
Is L in the above formula slope or horizontal distance?



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Sources of Errors in EDM Measurements

- Nature:
 - Can you think of some examples?
- Operator
 - Can you think of some examples?
- Instrument
 - Can you think of some examples?

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Error in EDM Measurements

$$\text{Error} = \pm (A \text{ mm} + D \times B \text{ ppm})$$

- A: Absolute error constant, depends on instrument type and manufacturing quality.
- B: Relative error constant (distance-dependent).
- D: Measured distance

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EDM Error: Examples

- Example 1: A distance of 1,000 ft was measured by an EDM with $\pm(5\text{mm} + 5\text{ppm})$. What is the error in this measurement?
- Example 2: A distance of 10 ft was measured by an EDM with $\pm(5\text{mm} + 5\text{ppm})$. What is the error in this measurement?

Answer # 1: $\pm 0.0210\text{ft}$; Answer # 2: $\pm 0.01605\text{ft}$

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EDM Accuracy: Examples

- What is the Accuracy Ratio in Example 1?

$$\text{Accuracy ratio} = \text{Error/Distance}$$

The book incorrectly mixes accuracy ratio with precision ratio. We will use the term "accuracy ratio."

- What is the Accuracy Ratio in Example 2?

What do these examples tell us about when to use an EDM and when to use a measuring tape (think of cumulative error from previous lecture)?

Answer # 1: 1/47,619 Answer # 2: 1/623

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Surveying Specifications

- Typically, acceptable Accuracy Ratio is set by legislation or policy
- Varies by location and importance of project. Examples:
 - High-cost urban areas: 1/10,000
 - Railways: 1/7,500 to 1/10,000
 - Gravel road: 1/3,000

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Prism Constant

- Manufacturers usually calibrate their EDMs to a particular reflector (prism).
- If a different prism is used, a prism constant (also called reflector constant) should be determined and entered into the EDM.
- Use EDM and reflector of the same brand.
- Prism constant is essentially a correction factor.



1. Measure AB, BC and AC
2. $AC + K = (AB + K) + (BC + K)$
3. $K = AC - (AB + BC)$
4. K is the prism (reflector) constant.

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