Measurement Errors and Their Effects - Assignment

Complete this assignment prior to the presentation.
Have fun.

True or False

T	**F**	1. Random errors can be completely eliminated from a measurement.
T	F	2. Standard deviation is a precision indicator.
T	F	3. It is possible to have a measurement set that is accurate but not precise.
T	**F**	4. You can measure an angle twice as accurately using a total station with a 2" manufacturer's stated angle accuracy than using one with a 4" stated accuracy.
T	**F**	5. Determining a point elevation by differential leveling is an example of a direct measurement.
T	**F**	6. It's not really possible to state a measurement-based result to a 100% confidence level. Just say "plus or minus infinity."
T	F	7. A least squares adjustment can adjust random and systematic errors. It can but it shouldn't.
T	**F**	8. A discrepancy is the difference between the same quantity measured by two different field crews.

Choice For each of the following errors indicate the source and type

Source		***Type***	
E	Environment	M	Mistake
I	Instrumental	S	Systematic
P	Personal	R	Random

Source			***Type***			***Error***
E	**I**	P	M	S	**R**	Sticking compensator on automatic level.
E	I	**P**	M	**S**	R	Incorrect reflector offset in total station.
E	**I**	P	M	S	**R**	Manufacturer's stated angle accuracy for a total station.
E	I	P	M	S	**R**	Heat waves when sighting across pavement.
E	I	P	M	S	**R**	GPS multipath.
E	**I**	P	M	**S**	R	The crosshairs in a total station are slightly rotated and off center.
E	I	P	M	**S**	R	Magnetic declination

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Question (1) What is a *degree of freedom*?

An extra measurement beyond what is necessary to determine a parameter

Question (2) Why would a minimally constrained adjustment be performed?

To check how well the measurements fit in a network by allowing them to move.

Question (3) What are *a priori* errors and what are they used for?

A priori mean before (prior to). It is an indication of what we think the measurement errors are before they are adjusted.

Question (4) Your new survey tech got to run the manual total station on a lot survey for the first time. You checked the total of her measured angles on the loop traverse that was run through the six property corners and came up with 720°00'36". What was her measurement random error per angle?

This is an error if a series: the same error repeated each time.

$$E_{series} = E\sqrt{n} \Rightarrow E = \frac{E_{series}}{\sqrt{n}} = \frac{36''}{\sqrt{6}} = \pm 14.7''$$

Question (5) Why balance foresight and backsight distances in differential leveling?

It allows distance-based systematic errors to cancel because they are added on the BS and subtracted on the FS.

Question (6) This one could require a little bit of digging. For a horizontal network:

Part (a) does your primary survey adjustment software have an option to check ALTA/ACSM adherence?

Part (b) How does your software determine the size of the 95% confidence interval error ellipse?

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Extra credit
To re-establish the lost E1/4 corner of Section 20 a base receiver is set up over the existing NE corner and a roving unit on a 2 meter rod is used to measure a distance of 5283.44 ft to the existing SE corner. What is the expected distance error between the NE and E1/4 corner location after it is re-set with the rover? Assume the base receiver set up height is 5.58 ft, its centering error is 0.005 ft, and the NE corner elevation is 1455 (scaled). It is 75°F, 29.95" Hg barometric pressure, 70% relative humidity, with wind gusting to 20 mph. The rover antenna centering error is 0.10 ft at both the SE and E1/4 corners. Both receivers have a manufacturer's stated horizontal accuracy of 8mm + 1 ppm and vertical accuracy of 15 mm + 1.5 ppm.

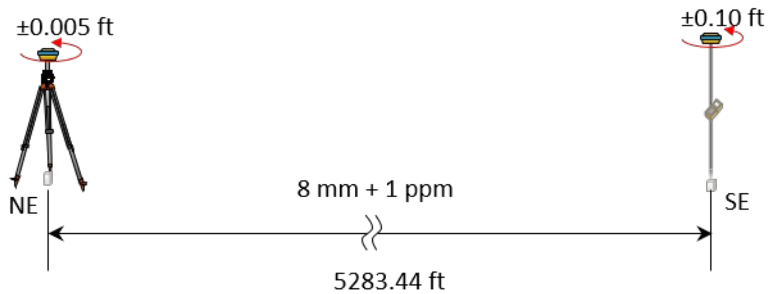
This problem is a good example of how errors can propagate in various combinations when multiple measurements and computations are involved.

The pertinent information, of all that provided, is the measured distance, centering errors, and horizontal accuracy specifications.

Things that have to be taken into account:

- The NE-SE measured distance has an expected error
- The NE-E1/4 distance that will be measured out has a propagated error from the NE-SE distance.
- The process of measuring the NE-E1/4 distance is also subject to error.

1. NE corner to SE corner measurement error



Convert 2 mm to ft

$$8\ mm \times \frac{1\ m}{1000\ mm} \times \frac{39.37\ in}{1\ m} \times \frac{1\ ft}{12\ in} = 0.026\ ft$$

Use *Error of a Sum* to determine error in the full length

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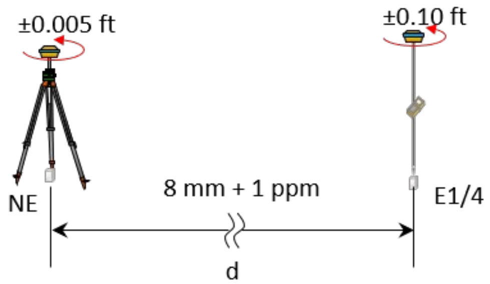
$$E_{NE-SE} = \sqrt{E_{GPS1}^2 + E_{MSA} + E_{GPS2}^2}$$
$$= \sqrt{0.005^2 + \left[0.026 + \frac{5283.44(1)}{1,000,000}\right]^2 + 0.10^2}$$
$$= \pm 0.105\ ft$$

The measured 5283.44 distance has a ±0.105 ft error.
This error must be propagated into the shorter distance to set the E1/4 corner.

2. NE corner to E1/4 corner distance error



This error is propagated error from the NE-SE distance measurement

Because this is an interior Section line, the lost quarter corner would be set at half the total distance. We can write this as a product:

$$d = 0.5 \times L$$

L is the NE-SE distance.

The *Error of a Product* is

$$E_{Product} = \sqrt{(AxE_B)^2 + (BxE_A)^2}$$

For our product, A=L and B=0.5.
We computed the error in L as ±0.105 ft
Because 0.5 is exact, it has no error: $E_{0.5}=0$

Substituting the values in the Error of a Product equation:

$$E_d = \sqrt{(L \times E_{0.5})^2 + (0.5xE_L)^2}$$
$$= \sqrt{(5283.44 \times 0)^2 + (0.5x0.105)^2}$$
$$= \pm 0.0525\ ft$$

This is the uncertainty in the distance that must be measured based on the error in the NE-SE measured distance.

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3. Measuring out the NE corner to E1/4 corner distance

The total error in NE-E1/4 distance after it is measured out consists of:

(a) The ±0.0525 ft uncertainty of the distance the will be measured out; E_d

(b) The base to rover measurement error

The distance error (a) and measurement error (b) are combined in an *Error of a Sum* to determine the expected error in the total distance.

$$E_{NE-E1/4} = \sqrt{(E_d^2) + (E_{GPS1}^2 + E_{MSA}^2 + E_{GPS2}^2)}$$

$$= \sqrt{(0.0525^2) + \left(0.005^2 + \left[0.026 + \frac{2641.72\,(1)}{1,000,000}\right]^2 + 0.10^2\right)}$$

$$= \pm 0.117\ ft$$

The expected distance error between the
NE corner and the re-set E1/4 corner is **±0.117 ft**

(note, this is a precision of 1/22,000)