Rural Land Administration

Level-III

Based on March 2022, Version II Occupational Standard

Module Title: Setting out Basic Surveying Data

LG Code: AGR RLA3 M06 LO (1-3) LG (17-19)

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Table of Contents

Introduction to the Module

Setting out Basic Surveying Data module covers the competence required to collect and set out basic surveying data. It requires the ability to plan and execute the collection and set out operation, in a team environment.

LG #17	LO#1- Prepare and execute computation

Instruction shee-1

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Collecting Basic Surveying Data
- Computations of angles, bearings and distances
- Conversions between polar and rectangular modes
- Traverse adjustment

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform computations on specified angles, bearings and distances.
- Conduct conversions between polar and rectangular modes
- Perform computations on coordinates of a simple closed traverse
- Perform computations on the missing elements of a travers
- Perform computations on adjusted coordinates of a traverse.
- Identify and correct errors and mistakes
- Adjust Traverse miss-closer computations
- Apply adherence of organizational practices
- Plan and adhere OHS requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

1.1. Collecting Basic Surveying Data

1.1.1. Preparing for Surveying Data Collection

Before any surveying activities, surveying instruments shall be operated according to manufacturer specification. A Survey plan is prepared by a Surveyor showing the results of a survey, with distances (horizontal), angles and areas of appropriate, improvements. The plan may be prepared for subdivision or for showing the location of existing boundaries (re-establishment plan). Laws and other administrative rules and guidelines for a uniform implementation of the system should regulate the role of a land registration system like the cadaster. These regulations should content as well some technical demands and rules for using the system and for maintaining it.

- The cadaster should be a parcel-based system (a piece of land belonging to a defined person or group of persons), i.e. information is geographically referenced to unique, well-defined units of land. These units are defined by formal boundaries marking the extent of land. Each parcel is given a unique parcel-number.
- Parcels are described with graphical and textual data. The cadaster shows their scope and the part of the surface to which they extend. All relevant facts, such as designation, location, size and use, plus the boundaries are based on cadastral surveys in which technical way ever.
- All information should be stored in a retrievable way, maintainable and updated by using the most economic methods in surveying and storing the data. The cadaster should be the only basic information system in the country. All users should be committed to use it for their own parcel-based special information systems so interrelations between different systems are possible.
- The cadaster should be accessible to the public in accordance to the rights of protection of individual interests.

- The users of the cadaster should pay the services offered by the cadastral agencies. The provision of information from the system should be more or less based on cost recovery.

Data collection : Cadastral surveys may include

- **Original surveys** - measure the unknown lengths and bearings of boundaries , which no earlier survey has been done.
- **Resurveys-** Reestablish the boundaries of a parcel for which survey have previously been done.
- **Subdivision surveys-** subdivide land into smaller parcels in accordance to an approved subdivision plan.
- **Consolidation / Amalgamation** of parcels as per an approved plan.

The cadastral records content all describing data to the parcels. These records can be kept in books, record cards or in a database on a computer. The form of the database may be held on a local PC-system like MS Access in a very simple manner or in a nation-wide operating computer-system. Normally analogue processes can be formed in a computer database.

The data can be given away on paper as well as in form of normal ASCII-files so that customers can use these data as input in their special PC based databases. Links to the graphical part of the cadaster via the parcel number are possible. Still the parcel and its identifier (parcel number) seems to be the easiest and best imaginable basic unit for most purposes. Development of more sophisticated data bases are object oriented. There all information is linked to points, polygons etc. Parcels are formed out of these objects. This kind of data base has a lot of benefits but the design is very complicated one so that developing countries should not start building up a cadastral system with such a data base design.

Minimal elements of the cadastral records should be the parcel number, the name of the land owner and the size of the parcel. Additional elements can be registered as well but this is always a balance between cost and benefit and should only be registered if the maintenance is organized. Stored details for each parcel in the cadastral records may be

- Name, date of birth, address, shares of the land owner,
- Location of the parcel, like street-name, house number, center-coordinates,
- District and parcel-number,
- Area of the parcel,
- Type of land use,
- Results from official soil assessment,
- Internal information about year of creation of the parcel, year of maintenance, number of cadastral maps, number of survey plans,
- Number of folio and property in the land register,
- Additional details about the parcel, like parcel is part of a consolidation project, polluted soil, historical monuments, parcel is part of a nature reserve or a water reserve etc.

Errors and Mistakes Correction

Science and engineering often involves measurements of different types. In geodesy and surveying, geometrical quantities (such as angles, distances, heights, etc.) or physical quantities (e.g. gravity) are directly measured, producing large amounts of data which need to be processed. To some extent, a surveying project may be considered as a data production process, from data collection, data processing, to final presentation (graphically and/or digitally).

Statistically speaking, field observations and the resulting measurement are never exact. Any observation can contain various types of errors. The collected data are never exact and there will always be a degree of variance regardless of the survey instrument or method used. These variances are known as errors and will need to be reduced or eliminated to maintain specific survey standards. Even when carefully following established surveying procedures, observations may still contain errors. Errors, by definition, are the difference between a measured value and its true value. The true value of a measurement is determined by taking the mean value of a series of repeated measurements. Surveyors must possess skill in instrument operation and knowledge of surveying methods to minimize the amount of error in each measurement.

Mistakes are errors that arise from inattention, inexperience, carelessness and poor judgment or confusion in the mind of the observer.

Appropriate corrections are made by:

- Properly leveling the survey instrument and targets.
- Balancing foresight and back sight observations.
- Entering the appropriate environmental correction factors in the data collector.
- Entering the correct instrument heights, targets heights, and prism offset in the data collector.
- Periodically calibrating the surveying equipment

In some measurement, errors are unpredictable and are often caused by factors beyond the control of the surveyor. Their occurrence, magnitude, and direction (positive or negative) cannot be predicted. Errors of this type are compensating and tend to at least partially cancel themselves mathematically. Because the magnitude is, also a matter of chance they will remain, to some degree, in every measurement.

Recording and Validating a Survey

Recording: the data collector can record measurements and additional information.

Validating a Survey:

To check each **recorded** and calculated value, v**alidity** determines what **survey** questions to use, and helps ensure that data collectors are using questions that truly **measure** the issues of importance.

- Step 1: Establish Face Validity. This two-step process involves having your survey reviewed by two different parties.
- Step 2: Run a Pilot Test.
- Step 3: Clean Collected Data.
- Step 4: Use appropriate Analysis method. eg. Principal Components Analysis (PCA)
- Step 5: Check Internal Consistency.
- Step 6: Revise Your Survey.

Finalize the Collection Process

Surveying may be defined as the science of determining the position, in three dimensions, of natural and man-made features on or beneath the surface of the Earth. These features may then be represented in analog form as a contoured map, plan or chart, or in digital form as a three-dimensional mathematical model stored in the computer. This latter format is referred to as a digital ground model (DGM).

When the above logistics are complete, the field work – involving the capture and storage of field data – is carried out using instruments and techniques appropriate to the task in hand. The next step in the operation is that of data processing. Computer, if not all, of the computation will carry out the majority,, ranging in size from pocket calculator to mainframe. The methods adopted will depend upon the size and precision of the survey and the manner of its recording; whether in a field book or a data logger.

Data representation in analog or digital form may now be carried out by conventional cartographic plotting or through a very automated system using a computer-driven flat-bed plotter. In engineering, the plan or DGM is used for the planning and design of a construction project. This project may comprise a railroad, highway, dam, bridge, or even a new town complex. No matter what the work is, or how complicated, it must be set out on the ground in its correct place and to its correct dimensions, within the tolerances specified. To this end, surveying procedures and instrumentation are used, of varying precision and complexity, depending on the project in hand.

1.2.Computations of Angles, Bearings and Distances

Azimuths are horizontal angles observed clockwise from any reference meridian. In plane surveying, azimuths are generally observed from north, but astronomers and the military have used south as the reference direction.

Bearings are another system for designating directions of lines. The bearing of a line is defined as the acute horizontal angle between a reference meridian and the line. The angle is observed from either the north or south toward the east or west, to give a reading smaller than 90°.The letter N or S preceding the angle, and E or W following it shows the proper quadrant.

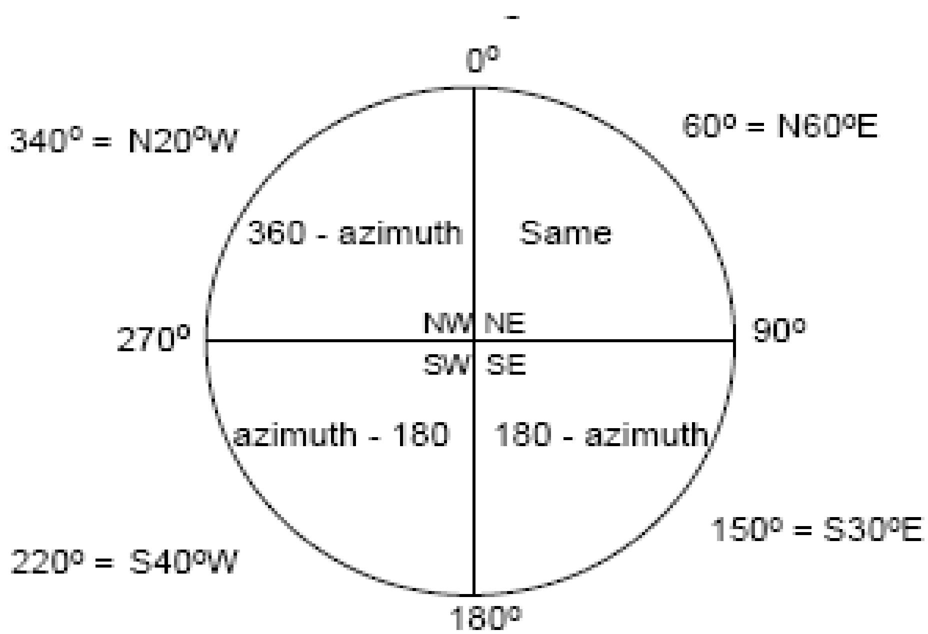


Figure 1.1 Azimuth and Bearing Conversion quadrant

1.3. Conversions between polar and rectangular modes

Rectangular coordinates

Rectangular coordinates, also known as Cartesian coordinates, specify the position of a point in a two- or three-dimensional space using the coordinates of the point's intersection with each of two or three perpendicular axes. The rectangular coordinates are typically represented as (x,y) for two-dimensional space or (x,y,z) for three-dimensional space.

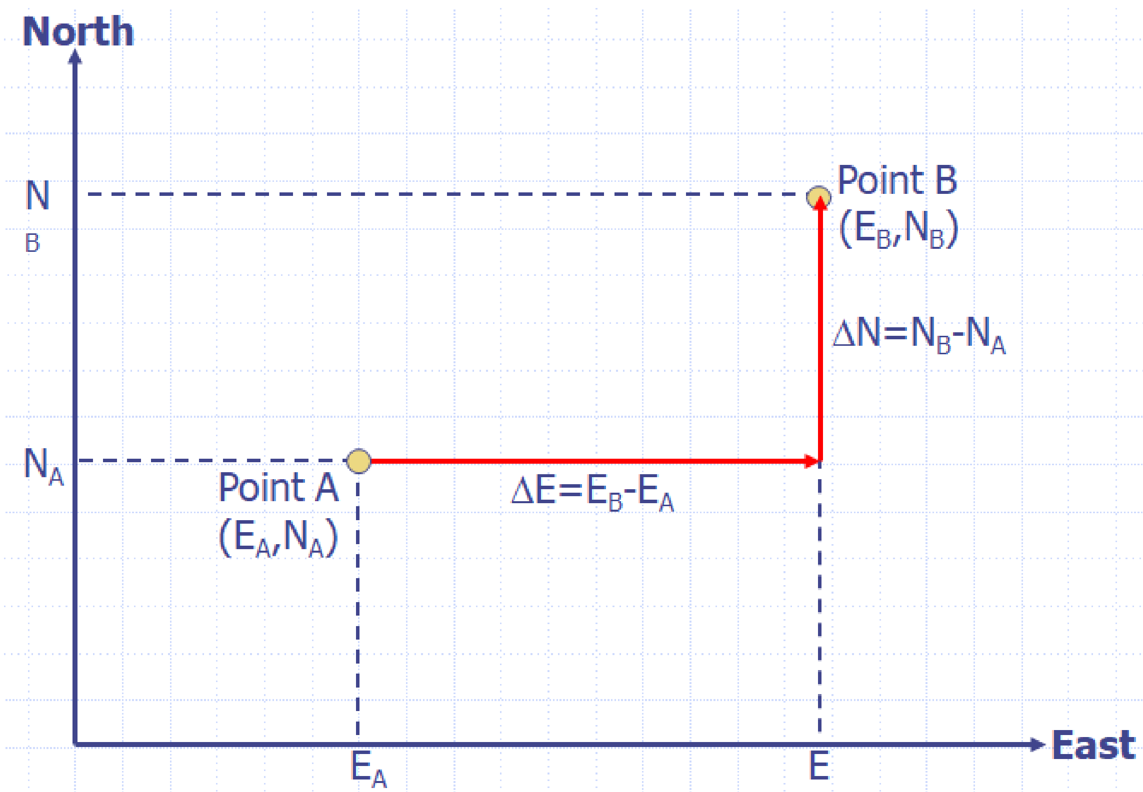


Figure 1.2 Rectangular coordinates

Polar coordinates

Polar coordinates describe the position of a point in terms of its distance from a fixed point (the origin) and its angle from a fixed direction (usually the positive x-axis). Polar coordinates are represented as (r,θ), where r is the radial distance from the origin to the point, and θ is the angle (in radians) between the positive x-axis and a line drawn from the origin to the point.

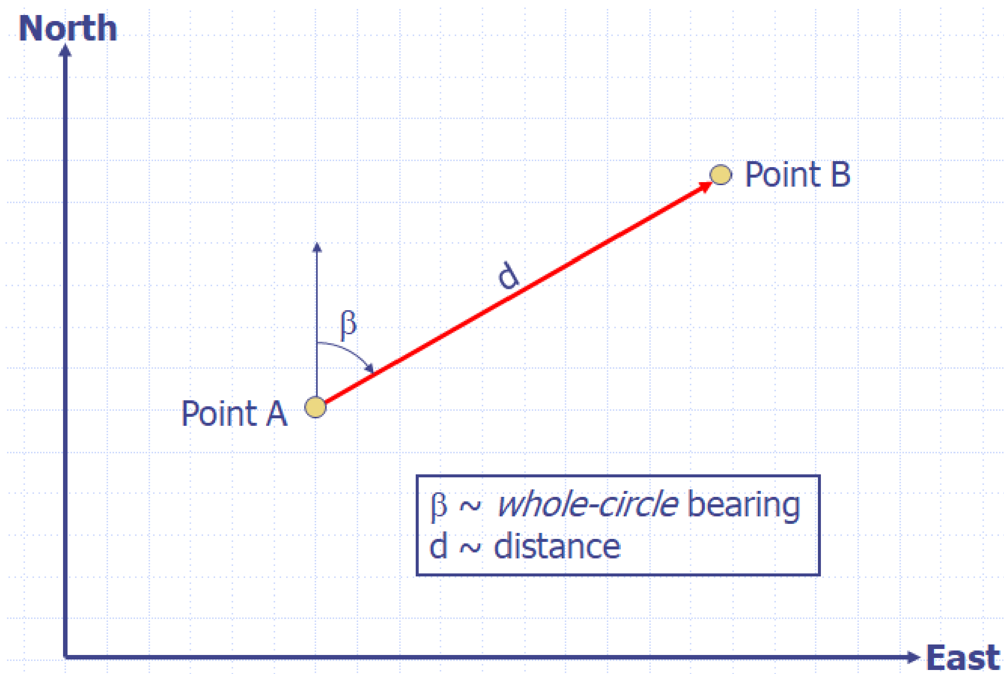


Figure 1.3 Polar coordinates

Coordinate conversions

Rectangular to polar

$$\beta = \tan^{-1}\left(\frac{\Delta E}{\Delta N}\right)$$

$$d = \sqrt{\Delta E^2 + \Delta N^2}$$

Polar to rectangular

$$\Delta E = d \sin \beta$$

$$\Delta N = d \cos \beta$$

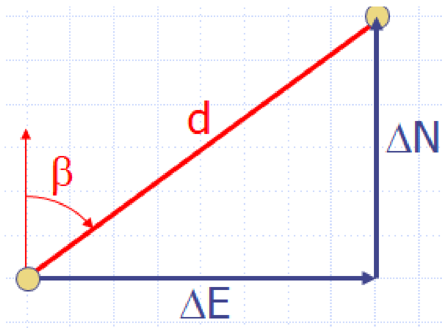


Figure 1.4a Polar Coordinates

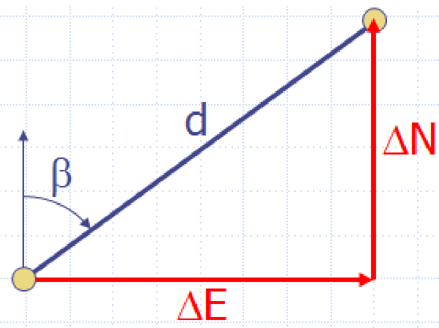


Figure 1.4b Rectangular Coordinates

The Polar and Join can easily be calculated using basic trigonometric functions:

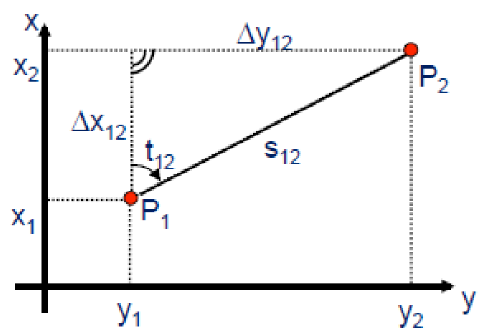
The Polar – Polar Coordinates

Given: t_{12} and s_{12}

To calculate: Δx_{12} and Δy_{12}

Solution: $\Delta y_{12} = S_{12} \sin t_{12}$

$\Delta x_{12} = S_{12} \cos t_{12}$



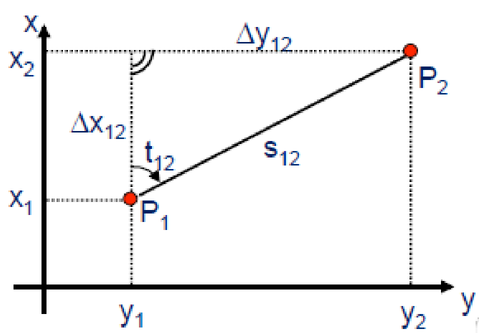
The Join – Rectangular Coordinates

Given: Δx_{12} and Δy_{12}

To calculate: t_{12} and s_{12}

Solution: $s_{12} = \sqrt{\Delta y_{12}^2 + \Delta x_{12}^2}$

$t_{12} = \arctan\left(\frac{\Delta y_{12}}{\Delta x_{12}}\right)$



The Polar: Example

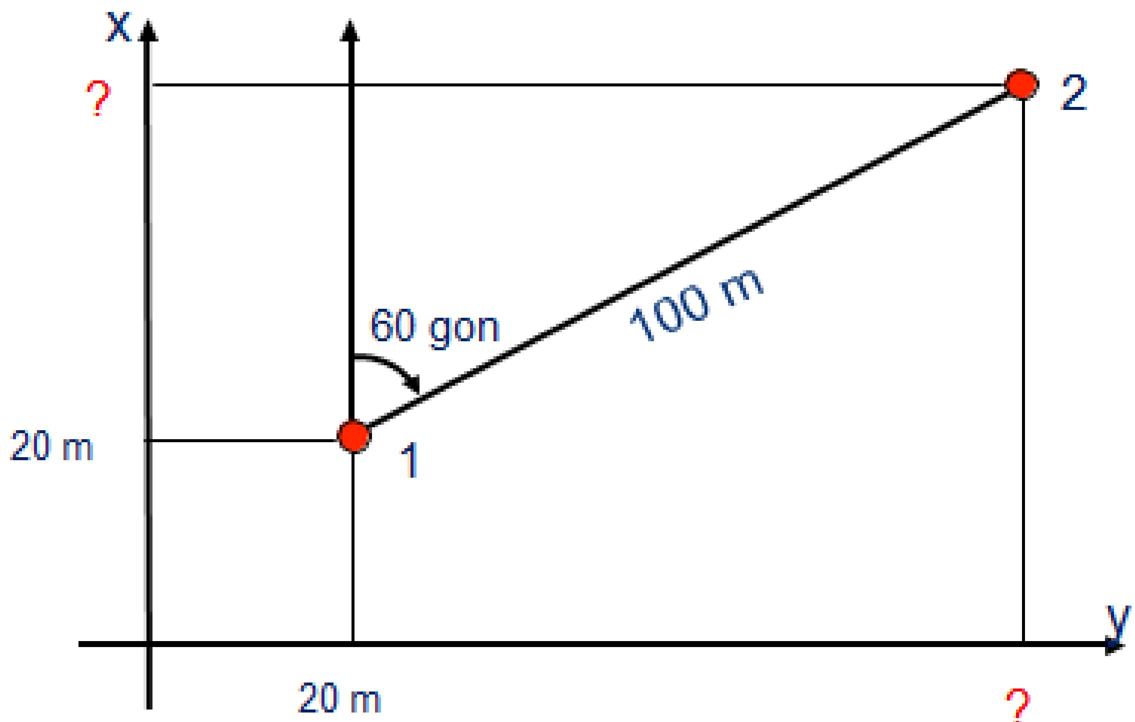


Figure 1.5 the Polar: Example

Given: s_{12} and s_{12}

X1 and Y_1

To calculate: X_{12} and Y_{12}

X_2 and Y_2

Solution:

y12 = S12 sin t12 = 100·sin (60) = 80,90 m

X12 = S12 cos t12 = 100·cos (60) = 58,78 m y2 = y1 + y12 = 100,90 m

X2 = x1 + x12 = 78,78 m

1.4. Traverse Adjustment

Introduction to Traverse

A traverse is a continuous series of connected lines of known lengths related to one another by known angles. The lengths of the lines are determined by direct measurement of horizontal distances, slope measurement, or by indirect measurement using the methods of stadia or the sub tense bar. The line courses run between a series of points are called traverse stations. The angles at the traverse stations, between the lines are measured by tape, transit, theodolite, compass, plane table, or sextant. These angles can be interior angles, deflection angles, or angles to the right. The lengths and azimuths or bearings of each line of the traverse are estimated through field measurements. The lengths are horizontal distances, and the azimuths or bearings are true, magnetic, assumed, or grid.

There are two types or classes of traverses. An open traverse is called a first-class traverse. It starts at a point of known or assumed horizontal position with respect to a horizontal datum, and terminates at an unknown horizontal position. Thus, open traverses end without closure. Open traverses are used on route surveys, but should be avoided whenever possible since they cannot be properly checked. Measurements in open traverses should be repeated to minimize mistakes. A closed traverse is called a second-class traverse. It starts at a known or assumed horizontal position and terminates at that point (i.e., loop traverse), or it starts at a known horizontal position and terminates at another known horizontal position (i.e., connecting traverses). Both the measured angles and lengths in a closed traverse may be checked.

Prepare to Perform Traverse Computations

Traverse is a method in the field of surveying to establish control networks. It is also used in geodesy. Traverse networks involve placing survey stations along a line or path of travel, and then using the previously surveyed points as a base for observing the next point. Traverse networks have many advantages, including:

- Less reconnaissance and organization needed;
- While in other systems, which may require the survey to be performed along a rigid polygon shape, the traverse can change to any shape and thus can accommodate a great deal of different terrains;
- Only a few observations need to be taken at each station, whereas in other survey networks a great deal of angular and linear observations need to be made and considered;
- Traverse networks are free of the strength of figure considerations that happen in triangular systems;
- Scale error does not add up as the traverse is performed. Azimuth swing errors can also be reduced by increasing the distance between stations.

The traverse is more accurate than triangulateration (a combined function of the triangulation and trilateration practice).

Frequently in surveying engineering and geodetic science, control points (CP) are setting/observing distance and direction (bearings, angles, azimuths, and elevation). The CP throughout the control network may consist of monuments, benchmarks, vertical control, etc. There are mainly two types of traverse. Traverse may be either a closed traverse or an open traverse.

1. **Closed traverse:** the traverse which either originates from a station or returns to the same station completing a circuit or runs between two known stations, is called a closed traverse.
2. **Open traverse:** the traverse which neither returns to its starting station nor closes on any other known station, is called open traverse.

According to the accuracy of the traverse, legs are measured directly on the ground either by chaining or taping of the traverse. Angles, the angle between consecutive traverse legs are measured with a theodolite by setting up the instrument at each station in turn. If the co- ordinate of one station and the true bearing of the traverse legs connected to it are known, the co- ordinate of the other traverse station may be calculated with the following formula.

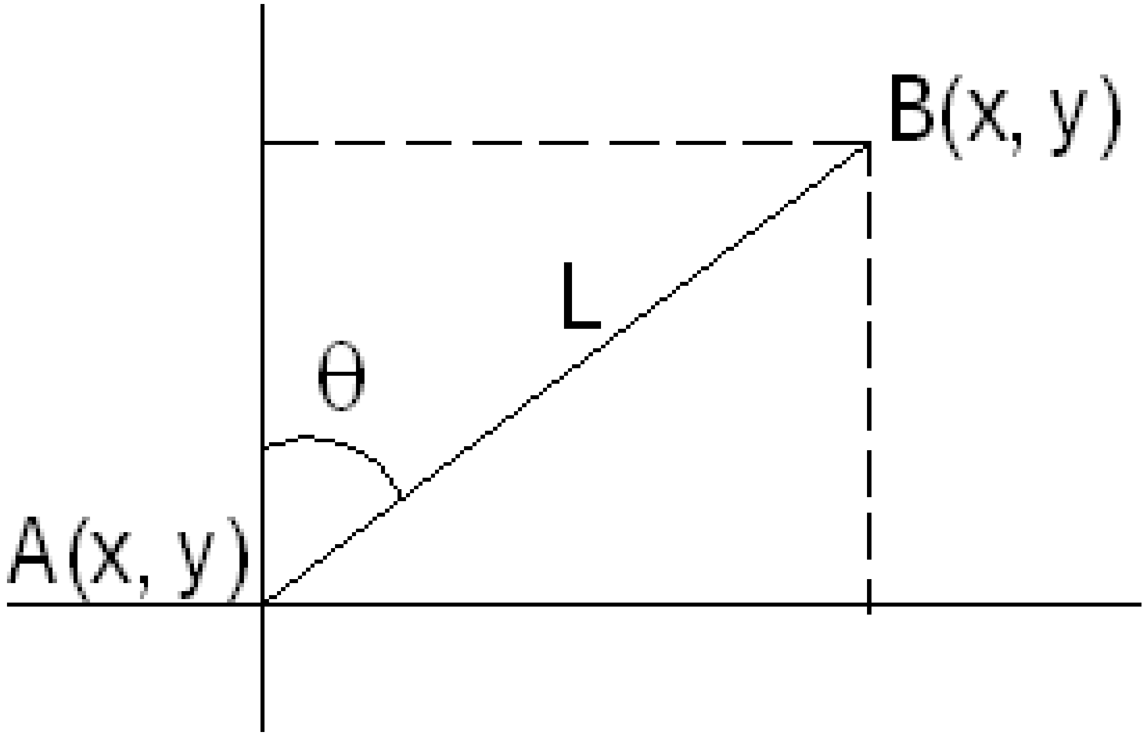


Figure 1.6 Rectangular coordinate

1. X co- ordinates of B = X co- ordinates of A + L sin θ
2. Y co-ordinates of B = Y co-ordinate of A + L cos θ

On the basic of measuring the relative direction of the traverse legs, the method of theodolite traverse, may be divided in two to groups.

- **A.** By measuring the angles between the two consecutive traverse legs
- **B.** By measuring the direct bearing of traverse legs

The first method is generally adopted for long traverse, when higher degree of accuracy is required. In this method, the bearing of the starting and closing traverse legs are generally determined by making astronomical observation to either pole star or sun.

The second method is used when it is not possible or desirable to make an astronomical observation obtaining the true bearing of the starting and the closing traverse legs and also when higher accuracy is not required.

Traverse fieldwork consists of the following steps:

- Select station positions as close as possible to the objects to be located.
- Mark the stations with stakes with tacks or with stone or concrete monuments set flush with the ground with a precise point marked on the top by a chiseled cross, drilled hole, or bronze tablet.
- Make angle and distance measurements.
- Place signals at each station such as a range pole to be used for taping and angle measurement. The forward and backward directions for any traverse need to be defined. The order in which measurements are made usually is called the forward direction. Loop traverses should be measured counterclockwise around the loop. The angles of the traverse should be measured clockwise from the backward direction to the forward direction. Most highway surveys and other connecting or open traverses are based on measurement of deflection angles. Either interior or deflection angles can be used for a closed traverse -- we will use interior angles. If angle and distance measurements are done separately, the field notes for each operation will be kept separately. If both measurements are done together, you might want to keep the field notes together.

Closed loop traverse computation procedures

1. The sum of measured interior angles should be equal to (2n-4) *90, where n= the number of sides of traverse
2. If the exterior angles are measured, their sum should be equal to (2n+4) *90 where n=number of side traverse legs.

The angular error of closure is the difference between the sums of measured angles and their theoretical sum. The discrepancies are equally distributed among all the angles.

Performing Computations On Balancing and Finding Adjusted Coordinates of A Simple Closed Traverse

Balancing the traverse means making adjustment to remove any visible error. For balancing the traverse, the underlying objective is to adjust the traverse in such a way that the sum the latitude and departure should each equal to zero in closed loop traverse. The closing error, however it is distributed throughout the traverse such that the above-mentioned objective is achieved this operation is called **Balancing the traverse.**

There are different methods of balancing the traverse, however two of them are recommended at this stage.

1. Bowditch rule
2. Transit rule

According to the Bowditch rule error is proportional to the length of the side

Correction lat /dep = <u>Closure error in lat/dep</u> * length of the side

According to Transit rule

Correction lat/dep = <u>Closure error in lat/dep</u> * lat/dep of the side

1. Sum up all observed angle and check the sum with the **(n-2) * 180^0**

Where, (n-2) *180^0 = Nominal sum or theoretical sum

n = Number of station

Sum (observed) = Actual (practical)

Then, Error = Nominal – Actual

Correction $= \frac{error}{n}$

By using the given azimuth of the first line find the azimuth of all lines.

If it is **right hand traverse,** which means the direction of progress is clockwise);

Az of (23) = Az 12 + 180^0 - < ß at point '2'

Az of (34) = Az 23 + 180^0 - < ß at point '3' and follows for the other as looks like this.

If it is **left hand traverse,** which means the direction of progress is counter clockwise);

Az of (23) = Az 12+ < ß at point '2'- 180^0

Az of (34) = Az 23 + < ß at point '3'- 180^0 and follows for the other as looks like this.

Where; ß is adjusted angle

2. Find the latitude and departure of all lines and sum up to get closure error of departure &latitude.
3. Adjust the latitudes and departures by Bowditch rule.
4. Find the coordinates of all points.

Illustrative example 1

The following data is observed for a closed loop traverse ABCDEF. Using the given data calculate the coordinates of stations B, C, D, E, F.

Included clockwise angle	**Line**	**Distance (m)**
<FAB = $115^0 11'20''$	AB =	429.37
<ABC = $95^0 00'20''$	BC =	656.54
<BCD = $129^0 49'20''$	CD =	301.83
<CDE = $130^0 36'20''$	DE =	287.40
<DEF = $110^0 30'00''$	EF =	526.72
<EFA = $138^0 54'40''$	FA =	372.47

Coordinates	Azimuth
XA = 500.00	AB = $191^0 11'00''$
YA = 1000.00	

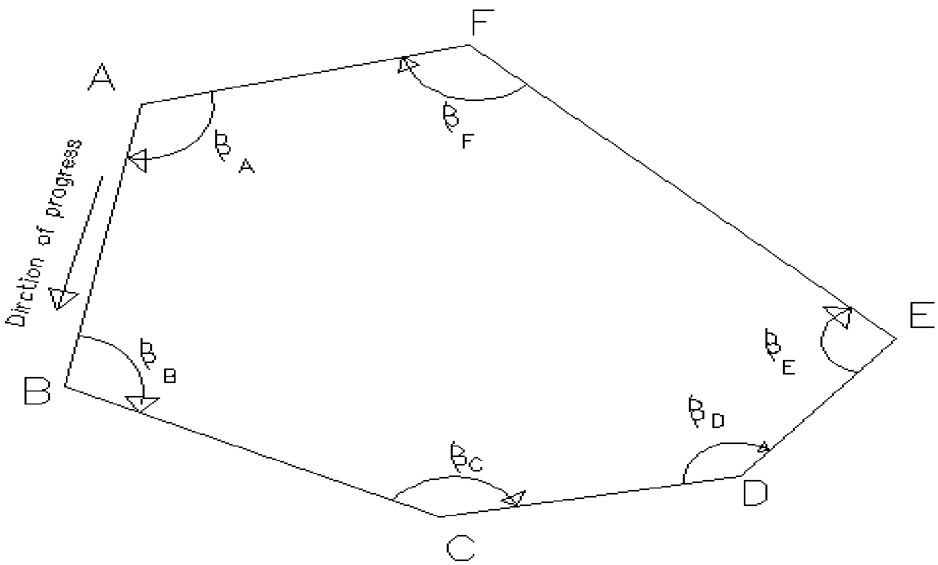


Figure 1.7 Closed loop traverse

Solution

1. **Computation of error, correction and adjusted angles**

$\sum ß_{practical} = ß_A + ß_B + ß_C + ß_D + ß_E + ß_F$

$= 720^0\ 02'00''$

$\sum ß_{Nominal} = (n-2) * 180^0$

$= (6-2) * 180^0$

$= 720^0\ 00'00''$

Error $= \sum ß_{Nominal} - \sum ß_{practical}$

$= -2'00''$

Correction = Error/ n

$= -20''$

Allowable error = 1' (n) 1/2

= 2'27" since error is less than allowable error the measurement is **ok!**

Therefore; the adjusted angles are

$<FAB = 115^0 11'20'' - 20'' = 115^0 11'00''$

$<ABC = 95^0 00'20'' - 20'' = 95^0 00'00''$

$<BCD = 129^0 49'20'' - 20'' = 129^0 49'00''$

$<CDE = 130^0 36'20'' - 20'' = 130^0 36'00$

$<DEF = 110^0 30'00'' - 20'' = 110^0 29'40''$

$<EFA = 138^0 54'40'' - 20'' = \underline{138^0 54'20''}$

$\sum \mathbf{720^0\ 00'00''}$

2. **Computation of azimuths**

Az AB = 191011'00"

$Az\ BC = Az\ AB + ßB – 180^0 = 106^0 11'00''$

$Az\ CD = Az\ BC + ßC - 180^0 = 560^0 0'00''$

$Az\ DE = AzCD + ßD - 180^0 = 6036'00''$

$Az\ EF = AzDE + ßE - 180^0 = 297^0 05'40''$

Az FA = AzEF + ßF -180^0 = $256^0$00’00“

Computation of latitude and departure

Table 1.1 Computation of latitude and departure

Side	Azimuth	Distance(m)	Departure	Latitude
AB	$191^0$11’00“	429.37	-83.276	-421.217
BC	$106^0$11’00“	656.54	630.524	-182.985
CD	$56^0$00’00“	301.83	250.228	168.781
DE	$6^0$36’00“	287.40	33.033	285.495
EF	$297^0$05’40“	526.72	-468.916	239.899
FA	$256^0$00’00“	372.47	-361.406	-90.109
∑		2574.33	+0.187	-0.136

Closure error of a traverse = [cldep2 + cllat2]1/2

= [0.1872 + -0.1362]1/2

= 0.231

Relative accuracy of a traverse = [Cl traverse / perimeter (Total length of a traverse)]

= 0.231/2574.33 = (0.231/0.231)/ (2574.33/0.231)

= 1: 11,144 ~ 1:11,000

3. **Adjustment of latitude and departure by using Bowditch rule.**

Let A = [closure error of latitude]

Total length of a traverse

And B = [closure error of departure]

Total length of a traverse

Since the summation of latitude is negative, the correction should be positive. And the summation of departure is positive, the correction should be negative.

Therefore;

Table 1.2 Adjusted departure and Adjusted Latitude

Line	Adjusted departure	Adjusted latitude
AB	-83.276 – [B*429.37] = -83.307	-421.217 – [A*429.37] = -421.240
BC	630.524 – [B*656.54] = 630.476	-182.985 – [A*656.54] = -182.950
CD	250.228 – [B* 301.83] = 250.206	168.781 – [A* 301.83] = 168.797
DE	33.033 – [B*287.40] = 33.012	285.495 – [A*287.40] = 285.510
EF	-468.916 – [B*526.72] = -468.954	239.899 – [A*526.72] = 239.927
FA	-361.406 – [B* 372.47] = -361.433	-90.109 – [A* 372.47] = -90.090

4. Computation of relative coordinates

$X_B = X_A + \text{dep AB}$

$= 500 + -83.307$

$= 416.693$

$X_C = X_B + \text{dep BC}$

$= 416.693 + 630.476$

$= 1047.169$

$X_D = X_C + \text{dep CD}$

$= 1047.169 + 250.206$

$= 1297.375$

$X_E = X_D + \text{dep DE}$

$= 1297.375 + 33.012$

$= 1330.387$

$X_F = X_E + \text{dep EF}$

$= 1330.387 + - 468.954$

$= 861.433$

Checking, $X_A = X_F$ + dep FA = 861.433 + -361.433 = 500.000 ………**OK!**

$Y_B = Y_A$ + lat AB

= 1000 + - 421.194

= 578. 806

$Y_C = Y_B$ + lat BC

= 578.806 + - 182.950

= 395.856

$Y_D = Y_C$ + lat CD

= 395.856 + 168 .797

= 564.653

$Y_E = Y_D$ + lat DE

= 564.653 + 285.510

= 650. 165

$Y_F = Y_E$ + lat EF

= 650.165 + 239.92

= 1090.0

Checking, $Y_A = Y_F$ + lat FA

= 1090.09 + -90.090 = 1000.000…. **OK!**

Finalize Task

Traverses are used to find accurate positions of a small number of marked stations. From these stations, less precise measurements can be made to features to be located without accumulating accidental errors. Thus, traverses usually serve as control surveys. When drawing construction plans, the stations can be used as beginning points from which to lay out work. When new construction of any kind is to be made, a system of traverse stations in the area must be established and surveyed.

Traverse surveys are made for many purposes to include:

- To determine the positions of exiting boundary markers.
- To establish the positions of boundary lines.
- To determine the area encompassed within a boundary.
- To determine the positions of arbitrary points from which data may be obtained for preparing various types of maps (i.e., establish control for map making).
- To establish ground control for photographic mapping.
- To establish control for gathering data regarding earthwork quantities in railroad highway, utility, and other construction work.
- To establish control for locating railroads, highways, and other construction work.

Self-Check – 1	

Name…………………………………………… ID………………………… Date…………….

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Define the term of traverse
2. What is the difference between open and closed traverse?
3. Put the formula used in balancing in case of Bowditch rule and Transit rule?
4. What is the difference between azimuth and bearing?

Operation Sheet -1

1.2 Procedures **to** Adjust Coordinates of a Simple Closed Traverse

A. Tools and equipment

- **I.** Theodolite
- **II.** Tripod
- **III.** Ranging pole
- **IV.** Tape
- **V.** Peg
- **VI.** Permanent Marker

B. Procedures

1. Computation of error, correction and adjusted angles
2. By using the given azimuth of the first line calculating the azimuth of all lines.
3. Computation the latitude and departure of all lines and sum up to get closure error of departure &latitude.
4. Adjustment of latitude and departure
5. Computation of relative coordinates

LG #18	LO #2 Gathering basic surveying data

Instruction sheet 1

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Operation of equipment
- Identification of different surveying methods
- Surveying techniques
- Collecting data and attributes

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Operate equipment according to organizational guidelines
- Identify different surveying methods
- Prepare Work procedures to perform surveying techniques.
- Apply surveying techniques
- Collect data and attributes
- Identify any discrepancy between specifications and actual activities
- Apply administrative and industry requirements for data collection
- Update Skills and knowledge on equipment operations

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

2.1. Operation of equipment

- **Types of Surveying Equipment & Their Uses**

Survey equipment refers to a variety of tools used to conduct surveying, which is the mapping and measurement of a certain environment (often a construction site) using specialized technology, equipment and mathematics.

A land surveyor uses instruments to make precise measurements of the earth's surface. From determining property boundaries to preparing construction sites, surveyors rely on certain equipment to do their jobs properly.

These tools include surveying instrument tripods, surveyors safety vests, planimeters, surveying bipods, levels, land surveying markers, marking machines, GPS equipment, surveying prisms, survey drones, land surveying rods, transits, stakes, grade rods and much more. Surveying contractors work out in the field, using technology like GPS, taking photos and making computations. They then use sophisticated software to process survey data and draft up maps, plans and survey reports.

Below is a summary of eight different types of surveying equipment and their uses:

1. Chains and Tapes

Taking accurate measurements is one of the most important tasks a land surveyor must complete. There is a variety of tools that can be used to take measurements including tapes, rulers, chains, and laser devices. Pocket tapes are ideal for small-scale measurements while measuring wheels, nylon coated steel tapes (Nyclad tapes), and fiberglass tape measures can be used for larger distances.

Recommended Products in this Category:

- **Nyclad Tape Measures** – Ideal for jobs requiring accurate measurements in harsh climates or inclement weather, nylon-coated steel tapes offer a flexible and durable option with the added benefit of an expansion coefficient similar to that of a steel drag chain.

- **Fiberglass Tape Measures** – Available in a variety of lengths, fiberglass tape measures are plastic-coated for durability but remain lightweight enough for easy portability and are less likely to kink the way a steel tape can.
- **Measuring Wheels** – Also known as a surveyor's wheel, measuring wheels feature a rotating wheel that measures the distance between two points while walking and is best suited for inspection or estimation work.
- **Laser Measuring Devices** – For the ultimate in precise measurement, laser technology is capable of measuring inclination, slope distance, and azimuth, in addition to making both vertical and horizontal calculations.

2. Compasses and Clinometers

A compass is an essential piece of equipment when surveying in unfamiliar territory, backcountry, or just orienting your position on a map. Compasses can be used to measure distances between two points while clinometers are used to measure the angle or elevation of slopes.

Recommended Products in this Category:

- SILVA Ranger 2.0 Quad Compass – Ideal for measuring direction over long distances, this mirror-sighted compass features quadrant graduations and offers a high degree of accuracy, precision, and durability.
- Brunton Omni-Slope Sighting Clinometer – This clinometer features a precision pendulum for fast, accurate readings and is housed in lightweight aluminum for durability and portability.
- Brunton TruArc 20-Mirror Compass - A modern upgrade to a trusted classic, this mirror-righted compass features the TruArc global needle system for consistent polarity and reduced magnetic interference. It also features a map magnifier, an Ever-North magnet, and a magnified readout.

3. Transits and non-Theodolites

These tools are used to measure both horizontal and vertical angles. Both tools have a minimum accuracy of one minute of angle, though the theodolite is generally recognized as the more accurate of the two, measuring angles to an accuracy of one-tenth of a second angle.

Recommended Products in this Category:

- Brunton GEO Pocket Transit – Equipped with a rare-earth magnet and sapphire jewel bearing, this transit allows for quick, simultaneous trend and plunge measurements, as well as readable dip measurements.
- SECO Total Station and Theodolite Rucksack – This heavy-duty but lightweight pack was designed to securely carry surveying instruments like a total station or theodolite.

4. Levels

A level can be used to read an elevation and determine differences in elevation between two points. These tools can be handheld, optical or digital, and are typically used in conjunction with level rods or tripods.
Recommended Products in this Category:

- Sokkia SDL50 Digital Level 28x – Offering easy, accurate measurements at the touch of a button, this digital level minimizes human error, combining user-friendly convenience with optimal functionality.
- SECO Hand Levels – For up-close work in even the roughest terrain, these hand levels feature lightweight but heavy-duty construction with both internal and replaceable external vial modules and 3-line mirrors to ensure a deviation of less than ¼ inch per 20 feet.
- Spectra Precision Laser Level LL500 – Designed for long-range measurements across an entire site, this precision laser level features rugged construction, highly accurate readings, a self-leveling system, and built-in “out of level” shutoff.

5. Safety Gear

Land surveyors work in all kinds of conditions and climates, but safety is always the primary concern. High-visibility gear and safety headwear are a must for all outdoor work crews.

Recommended Products in this Category:

- 3A Safety 3 Season Waterproof Thermal Jacket – Made with DUPONT-treated Teflon fabric, this waterproof jacket keeps you warm in even the harshest weather conditions while also offering maximum visibility.
- ML Kishigo Safari Hat – These full-brim hats offer 360-degree reflectivity while also keeping your head cool and well ventilated.
- SECO Class 2 Safety Utility Vest – Designed specifically for surveyors, this utility vest is made from durable ANSI/ISEA-compliant materials with a padded collar for comfort and multiple pockets for convenience.

6. Prisms and Reflectors

Prism systems are used to secure control points at a comfortable and accessible height for pinpoint accuracy. These devices can be mounted on surveying poles and used in conjunction with electronic distance measuring (EDM) instruments for improved accuracy.

Recommended Products in this Category:

- Sokkia Economy Tilting Prism – Available at an affordable price point, this tilting prism allows the user to quickly adjust the target from behind for accurate sighting.
- SECO Double Right Angle Prism – For compact size and precision, this double right-angle prism allows for easy determination of right-angle or perpendicular points between two targets.
- GeoMax GRZ122 360° High Accuracy Prism – This high-performance prism features a built-in point that allows the reflector to be positioned directly on the mark for pinpoint accuracy.

7. Magnetic Locators

When conducting a land survey, it is necessary to identify the location of certain features, such as manhole and utility covers, steel and iron pipes, underground tanks, and survey corner markers. Magnetic locators can be used to quickly and precisely locate ferrous materials like iron, steel, and rebar.

Recommended Products in this Category:

- Schonstedt Maggie Magnetic Locator – This "next generation" magnetic locator offers single-handed operation, maximum sensitivity, precision, and state-of-the-art ergonomics for comfortable use.
- ChrisNik HoundDog Magnetic Locator – With integrated Fence Ignoring Technology (FIT), this magnetic locator can sniff out hard-to-find survey markers even in the presence of metal fences and metal buildings.
- SubSurface Instruments Magnetic Locator – This combo kit includes both pipe & cable and magnetic locating, making it the perfect kit for utility-locating professionals in all industries, from gas to sewer, electric, water, and telecom.

8. Poles and Tripods

An unstable mount can throw off even the most precise of surveying instruments. Poles, tripods, and other mounting accessories are essential for surveyors to ensure solid, stable readings. These mounts can be used for all kinds of surveying equipment, including prisms, lasers, and levels. Recommended Products in this Category:

- SECO Quick Release 8ft Robotics Pole – Made from heavy-duty carbon fiber, this robotics pole offers an anti-rotation quick release feature and easy push-button operation.
- SECO Tri-Max Dual Lock Tripod – Offering a combination of dual locks, quick release, and twist lock features, this surveying-grade tripod delivers certified accuracy and unmatched stability.

- Dutch Hill Heavy-Duty Column Clamp for Instruments – This lightweight aluminum clamp features a standard 5/8-11 mounting stud with a 6-inch mounting plate for use with a wide variety of surveying instruments & laser levels.

When it comes to land surveying, having the right equipment is essential. Whether you are measuring angles, distances, or elevations, having the best tool for the job will ensure speedy and accurate measurements for every application.

2.2. Identification of different surveying methods

- Triangulation Surveying Method: The Triangulation method is a basic surveying method and is adopted when the surveyed area is large. The surveyor divides the entire area into a triangulation of networks.
- Traversing Surveying Method: Traversing is a circuit of survey lines that may be open or closed. When the linear measurements are carried out with a chain and a tape and the directions or horizontal angles are computed with a compass or a theodolite respectively it is called traversing.

- Innovations and technology: Surveying and land survey techniques are required in various fields like the positioning of earthwork structures, provision of maps with details of specified locations, measuring the distance between two distinct points, etc. Surveying requires GPS data from satellites that have high-precision electromechanical and optical instruments which are required for ensuring that the measurements are having accuracy.

✓ Computer-Aided Drawing (CAD)

Once the engineers have collected survey data, computer-aided drafting helps turn that data into a clear visual representation, like a map or any three-dimensional model. It permits for a greater level of perfection and details faster which could not be achieved with manual sketching.

✓ Global satellite data positioning

GPS data is significant for civil surveying since it allows for pointing the exact locations and coordinates by control networks. Where a visual assessment would not be sufficient for telling whether an object had shifted or a sunk foundation, the accuracy of GPS data allows engineers to know for sure. Trilateration is used in Global Positioning System (GPS) to locate the user's position, elevation and speed.

✓ Point cloud modeling

To develop and prepare 3D survey models with accuracy, engineers also often create a point cloud or a set of three-dimensional data points. The surveyor uses 3D laser-scanning technology for the generation of a data map of the area they wish to model. Once they have data that represents every surface they need, they can then bring the marked points together through point cloud modeling into a précised and detailed 3D model.

- **Fundamental principles of surveying**

There are two basic principles in which surveying are applied.

i. Detection of a point by the measurement of the given two points of reference

ii. Working from whole to part

- ✓ ***Detection of a point by the measurement of the given two points of reference***

According to this principle, the relative position of one point to be surveyed should be located and measured from at least two points of reference which have fixed positions previously.

- ✓ ***Working from whole to part***

According to this principle, it is always recommended to carry out survey work from whole to part. That is, when any area needs to be surveyed, first a control points system is to be established covering the whole area with high perfection followed by the minor details located almost roughly. This shall prevent the accumulation of errors and would expand to greater magnitudes. If not followed, it makes the task uncontrollable.

- **Primary methods of surveying**
  - ✓ Plane surveying method

Plane surveying is the one in which the earth's surface is considered as a plane and the earth's curvature is ignored. In such a type of surveying, a line joining any two stations is considered as a straight line. The triangle formed by joining any three points is considered as a plane triangle and the angles of the triangle are also considered as plain angles. The lengths of the triangle's sides are measured using Trilateration. A surveyor carries out surveying for small places with less than 250 square kilometer area and also carried out by local or state agencies like Research & Development department, Irrigation department, Railway department, etc.

- ✓ Geodetic surveying method

Geodetic Surveying is the method in which the earth's curvature is taken into consideration. It is generally extended over much larger areas. The line that joins any two stations is to be considered a curved line. The triangle formed by any three points is considered to be spherical and the angles of the triangle are also taken into account as spherical angles. Geodetic surveying is conducted by the National Survey and Mapping Organization, Survey of India Department and land surveyors carry out surveying for a larger area exceeding 250 square kilometers.

2.3. Surveying techniques

- **Techniques Used In Land Surveying**

✓ ***Global Positioning System (GPS):*** GPS is widely used in land surveying to determine precise positions on the Earth's surface. It relies on a network of satellites to provide accurate three-dimensional coordinates, allowing surveyors to establish control points and measure distances and angles with high precision.

✓ ***Total Station:*** A total station is an electronic instrument that combines electronic theodolite (measures angles) and electronic distance measurement (measures distances) capabilities. It can be used to measure angles, distances, and elevations of various points on the ground.

✓ ***Theodolite:***A theodolite is an optical instrument used to measure vertical and horizontal angles. It consists of a telescope mounted on a rotating base and is primarily used for angular measurements in land surveying.

✓ ***Leveling:*** Leveling is a technique used to determine the relative heights or elevations of points on the ground. It involves the use of a leveling instrument, such as a level or an automatic level, to measure the vertical differences between points.

✓ ***Electronic Distance Measurement (EDM):*** EDM instruments use electromagnetic waves, such as infrared or laser beams, to measure distances accurately. They are often integrated into total stations or used as standalone devices for distance measurements.

✓ ***Remote Sensing:*** Remote sensing involves collecting data about the Earth's surface from a distance, typically using aerial photography, satellite imagery, or LiDAR (Light Detection and Ranging) technology. These techniques provide detailed information about the terrain and can be used to create digital elevation models and orthophotos.

- ✓ ***Geographic Information System (GIS):*** GIS is a computer-based system used to capture, store, analyze, and present spatial data. It is commonly used in land surveying to manage and integrate survey data, create maps, perform spatial analysis, and generate reports.
- ✓ ***Photogrammetry:*** Photogrammetry uses photographs taken from different angles to measure distances, elevations, and three-dimensional characteristics of objects or terrain. It can be employed in land surveying to create accurate maps and digital models.
- ✓ ***Field Observation and Data Collection**:* Surveyors also rely on manual field observation techniques to collect data, such as measuring tapes, ranging poles, compasses, and clinometers. These tools are used for measurements, marking points, and recording field notes.
- ✓ ***Land Records and Legal Documentation:***Surveyors often conduct research in land records, historical maps, and legal documents to gather information about boundaries, property lines, and previous surveys. This information helps in establishing accurate survey control and resolving boundary disputes.

- **Uses of Land Surveying**

The primary uses of land surveying are described as follows:

1. Identification and positioning of different natural and man-made elements on the Earth's surface.
2. Accurate determination of global coordinates for specific locations worldwide.
3. Creation of topographic maps that exhibit a high level of precision and detail.
4. Establishment of boundary lines to define ownership boundaries, international borders, and other relevant demarcations.
5. Assessment of easements, encroachments, and land development activities.

Self-check-2

Name……………………………….ID………………………… Date………..….

I. **Write "true" if the statement is correct and "false" if the statement is in correct.**

1. GPS is widely used in land surveying to determine precise positions on the Earth's surface.
2. Surveying used for Identification and positioning of different natural and man-made elements on the Earth's surface.

II. Choose the correct answer

1. Which of the following is correct about the advantage of surveying?

A. Used for determination of global coordinates for specific locations worldwide

B. Used for Creation of topographic maps that exhibit a high level of precision and detail

C. Used for Establishment of boundary lines to define ownership boundaries, international borders D. All

2. Which one of the following is basic principle of surveying?

A. Work from whole to part

B. Setting out of point data

C. Collection of surveying data

D. Post processing of GNSS data

3. Which one of the following is true about geodetic surveying?

A. The earth's curvature is taken into consideration

B. The earth's surface is considered as a plane and the earth's curvature is ignored

C. Line joining any two stations is considered as a straight line.

D. The line that joins any two stations is not considered to be considered a curved line

LG #12	LO#3- Setting out basic surveying data

Instruction shee-3

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying and organizing set out data
- Setting out Basic surveying data
- Identifying and recording discrepancies

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify and organize Set out dada
- Set out Basic surveying data
- Identify and record any discrepancies

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet-3

3.1. Identify and organize Set out dada

By using surveying instruments, a wide range of data related to a specific area or location can be collected and set out. Some of the most common types of data that can be collected and set out using surveying instruments include:

1. **Location:** Surveying instruments can be used to measure and record the precise location of various features within an area, such as property boundaries, building corners, and natural landmarks.
2. **Elevation:** Surveying instruments can be used to measure the height and elevation of different points within an area, allowing for accurate topographic maps and site plans to be created.
3. **Distance:** Surveying instruments can be used to measure the distance between different points within an area, which is useful for determining property boundaries, planning roads, and creating digital terrain models.
4. **Angle:** Surveying instruments can measure angles and bearings between different points within an area for use in mapping and planning.

In cadastral surveying, various types of data can be set out, including:

1. **Cadastral boundaries:** This includes the physical limits of a parcel of land and may include its perimeter, corners, and any natural or artificial features used to define the parcel.
2. **Land ownership boundaries:** This includes the legal limits of land ownership, which are often defined by cadastral boundaries as well as legal documents such as deeds.
3. **Easements:** Easements are rights given to someone else to use a part of the land.
4. **Roadways and infrastructure:** Cadastral surveying can also be used to set out roadways and other infrastructure like buildings and utilities.
5. **Topographic features:** Cadastral surveying can also be used to set out topographic features such as hills, valleys, and streams.

The type of data that is set out depends on the purpose of the survey. For example, if the survey is being conducted for property registration purposes, then the focus will be on cadastral boundaries and land ownership boundaries. On the other hand, if the survey is being conducted for infrastructure development purposes, then the focus will be on roadways and utility lines.

3.2. Set out Basic surveying data

Setting out is the transfer of spatial data from a design, map or plan onto the ground. It involves the establishment of marks on the ground to define the position (x, y). Setting out therefore may be considered as the opposite of data collection surveying since it intends to determine by measurement the positions of existing features. In cadastral surveying, setting out will involve the placement of beacons to demarcate property boundaries and missing or lost monuments. Regardless of the task, good surveying practices and techniques in setting out are essential in order to minimize errors. Definition of setting out, often used, is that it is the reverse of surveying. Whereas surveying is a process for forming maps and plans of a particular site or area, setting out begins with plans and ends with the various elements of a particular plan correctly positioned on site.

In cadastral surveying, setting out refers to the process of marking the position of cadastral boundaries on the ground. This involves using survey measurements and reference points to correctly place and mark property boundary corners, boundary lines, and other features on the ground in accordance with established legal boundaries and jurisdictions. The setting out of cadastral boundaries is critical to ensure that property ownership, rights, and responsibilities are correctly established and upheld, especially in situations where there may be disputes or claims over land and property. It is important to note that cadastral surveying can also involve other activities such as boundary establishment, boundary retracement, and land record research. In cadastral surveying, several instruments are used for setting out boundaries and points. Typically, total stations are used for setting out GNSS points and coordinate points. In addition to this, specialized instruments may be required for cadastral surveying, including theodolites - to measure angles between points, Measuring tapes - to measure distances between points and Survey markers used to indicate the location of a point on the ground.

Methods of Setting out Survey are listed in the following way:

1. Chain and Tape Method

The chain and tape method is one of the oldest and simplest techniques for setting out surveys. It involves measuring distances using a chain or tape measure and establishing right angles using the **3-4-5** triangle method. This method is suitable for smaller projects with relatively simple geometries, such as boundary demarcations and small building layouts.

2. Total Station Method

Total station surveying is a modern technique that combines electronic theodolites and electronic distance measurement (EDM) instruments. It enables accurate measurements of angles and distances, along with the ability to record data electronically. With the total station method, surveyors can quickly establish reference points, measure distances, and set out precise coordinates on the site. This method is commonly used in building construction, road alignments, and infrastructure projects.

3. GPS/GNSS Method

Global Positioning System (GPS) or Global Navigation Satellite System (GNSS) technology is widely used in setting out surveys. GPS receivers receive signals from multiple satellites to determine accurate positions on the Earth's surface. This method allows surveyors to establish control points, measure distances, and calculate coordinates with high accuracy over large areas. The GPS/GNSS method is particularly beneficial for projects that involve vast terrains or require rapid data collection. GNSS surveys are particularly useful in staking widely spaced points, especially in areas where terrain or vegetation makes it difficult to conduct traditional ground surveys. With a conventional GNSS RTK rover, setting out is a rather slow and methodical procedure. This is because the pole needs to be held vertically at the same time as looking at the setting out information on the controller screen all the while moving the pole into position. The GNSS position is calculated to the antenna, which is fixed onto a 1.8 m or 2 m pole. Hence, for the setting out information on the screen to be correct, the pole must be held vertically by centering the pole bubble.

To set out a position accurately, it is needed to perform several tasks at the same time:

- Look at the setting out instructions and values on the controller screen
- Walk and orientate: Move the pole to the required position so that the stake values are close to zero
- Ensure the pole is vertical by centering the pole bubble

Fig 3.1 *Simplified setting out with GNSS/GPS instrument*

4. Optical Leveling

Optical leveling is employed to establish vertical control on construction sites. It utilizes a leveling instrument, such as a dumpy level or an automatic level, along with a leveling staff. Surveyors measure the difference in height between reference points, known as benchmarks, using the principle of line of sight. Optical leveling is crucial for setting out structures with specific elevation requirements, such as roads, pipelines, and buildings.

3.3. Identify and record any discrepancies

The errors/ discrepancies may be miss using of elements and any other issues like:

- Recording of illegal holder,
- Missing of Parcel identification number
- Missing of cause of dispute
- Unclosed polygon
- Miss use of land use type
- Boundary are compiled and recorded by the data encoder on an Errors and Discrepancies Record Sheet.

The Errors and Discrepancies Record Sheets/ field registration format are written records of the errors and discrepancies discovered during the production of the Cadastral Survey Sheets. Errors and Discrepancies Files are opened at the same time when work commenced on the preparation of parcel Record Books. The surveying crew leader then checked the details for accuracy, noted the nature and tried to find out the reason for the error or discrepancy.

Suggestions for recording discrepancies

- Make notes dark enough to be reproducible.
- Use standard abbreviations and symbols.
- Be consistent in style and lettering. Write tabulated figures inside and off column rulings. Align decimal points and digits vertically.
- Do not crowd information to a point where numbers or letters are hard to distinguish or some information is covered. Do not try to economize on paper.
- Do not write in margins of notes.

Self-Check – 3	Written test

Name…………………………………… ID…………………Date……………………….

Directions: Answer all the questions listed below.

I. Say true if the statement is correct and false if the statement is incorrect

4. Setting out is the reverse of surveying data collection.

5. Setting out can be performed by using only total station and GNSS/GPS instruments.

6. During setting out work, looking at the setting out instructions and values on the controller screen is not recommended.

7. Setting out by using 3-4-5 method is suitable for smaller projects with relatively simple geometries.

II. Short Answer Questions

1. What is setting out? Define it

……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………………

2. What is setting out in cadastral surveying?

……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………………

3. In cadastral surveying what type of area, done setting out?

……………………………………………………………………………………………
…………………………………………………………………………………………

Operation Sheet -3

3.1. Procedures to set out GNSS/GPS points

A. Tools and Equipment

I. GNSS receiver

II. Data collector or a tablet with the necessary software installed

III. Range pole or tripod for mounting the GNSS receiver

IV. Stake and flag to mark the location of the point on the ground

B. Procedures to set out GNSS points

1. Turn on the GNSS receiver and allow it to acquire satellite signals.
2. Connect the data collector to the GNSS receiver and make sure that it is receiving data.
3. Choose the point that you want to set out and enter its coordinates into the data collector or tablet using the software.
4. Place the range pole or tripod at the marked location where you want to set out the point.
5. Hold the GNSS receiver over the range pole or mount it on top of the tripod.
6. Wait for a few seconds until the GNSS receiver records the correct location of the point.
7. Mark the location of the point on the ground using a stake and a flag.
8. Repeat these steps for each point that you want to set out.

It's important to make sure that your equipment is calibrated properly and that you take enough measurements to ensure accuracy.

3.2. Procedures to set out coordinate points using a total station

A. Tools and Equipment

I. Total station

II. Tripod

III. Tape

IV. Reflector/prism

V. Pegs

B. Procedures to set out coordinate points using a total station

1. Set up the total station over a known benchmark or point with a known coordinate.
2. Orient the total station to face the first point you want to set out.
3. Enter the coordinates of the point into the total station's software.
4. Use the telescope and crosshairs to center the total station on the point.
5. Press a button on the total station to record the point's coordinates as measured by the instrument.
6. Mark the ground or place a stake at the physical location of the point where it was measured.
7. Repeat steps 2-6 for any additional points you want to set out.

Operation Sheet -3

3.1 Procedures to communicate basic GNSS/GPS software:

LAP Tes-3	Performance Test

Name……………………………….. ID……………………………..

Date…………………………………….

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **21** hours.

Task 1: Set out GNSS/GPS points using GNSS receivers

Task 2: set out coordinate points using a total station

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