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Introduction to Engineering Surveying I

©2017 Dr. Sarhat M Adam

BSc in civil Engineering

Msc in Geodetic Surveying

PhD in Engineering Surveying Space Geodesy

Note – The techniques shown in these slides are considered common knowledge to surveyors. Figures in the slides may be the authors own work or extracted from Instrument's Users Manuals, Surveying by Duhok universities staff and their materials, author's own Surveying, or various internet image sources.

Outlines

- Introduction
- Reading Materials
- Table of Contents
- History of Surveying
- Purpose of Surveying
- Basic concept of Surveying
- Basic Measurement
- Control Network
- Locating Position

Introduction

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- Course Details
  - Two courses in two semester
  - 6 units total for 2 courses.
  - 2 hrs Theory, 2 hrs practical
  - Activities involve lectures, practicals, tutorials, quizzes, and a field practice
  - Every 2 weeks a group discussion (Practical) and a quiz (5%).
  - Practicals involve carry out measurements and processing.

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- Course evaluation
  - 1st & 2nd semester 1st exam
    - Total =50 (20 theory, 10 practical, 20 activity)
  - 1st & 2nd semester final exam
    - Total = 50 (40 theory, 10 practical)

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- Course assessment
  - Excellent 90-100 %
  - Very good 80- 89 %
  - Good 70- 79 %
  - Average 60- 69 %
  - Pass 50- 59 %
  - Fail 00- 49 %

You're required to achieve a minimum of 50% to pass the course.

Introduction

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- Lecturers (Theory)
  - Dr. Sarhat M Adam (Sarhat@uod.ac)
  - Senior Lecturer Sami Mamlook
- Practical
  - Hishyar Ali
- Attendance monitoring system
  - < 90 % may lead to failing the cours.
  - Each 1 hr absence = 0.5 mark lose

Introduction-the Plan

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Date	Day	Lecture	Activities
10-Oct-17	Tuesday	Lecture 01: Introduction to Surveying	
17-Oct-17	Tuesday	Lecture 02: Error & Uncertainty	
24-Oct-17	Tuesday	Lecture 02: Error & Uncertainty (cont.)	Quiz 01 (5%)
31-Oct-17	Tuesday	Lecture03: Distance Measurment	
7-Nov-17	Tuesday	Lecture03: Distance Measurment (cont.)	Assignment 01 (5%)
14-Nov-17	Tuesday	Lecture04: Veritcal Control	
21-Nov-17	Tuesday	Lecture04: Veritcal Control	
28-Nov-17	Tuesday		PPT01 (Seminar Day 5%)
5-Dec-17	Tuesday	Lecture05: Levelling Applications	
12-Dec-17	Tuesday	Lecture05: Levelling Applications	
19-Dec-17	Tuesday	Lecture05: Levelling Applications	Quiz 02 (5%)
24-Dec-17	Tuesday		Midterm Exam Expected (20%)
9-Jan-18	Tuesday	Lecture06: Earht Works	
16-Jan-18	Tuesday	Lecture06: Earht Works	
23-Jan-18	Tuesday		Final exam expected (40%)

Reading Materials

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- Online Help in , Engineering Surveying on YouTube, or Web
- Surveying forum, for example engineeringsurveyor, http://www.engineeringsurveyor.com/
- Books - for example,
  - Introduction to Visual Basic® for Applications for Autodesk® AutoCAD®
  - Engineering Surveying 6th ed. W. Schofield and M. Breach
  - Engineering Surveying, Theory and Examination Problems for Students, V2, 2nd ed.
  - Surveying Engineering & instruments. Valeria Shank
  - Surveying; problem solving with theory & objective type questions.
  - ADJUSTMENT COMPUTATIONS, Spatial Data Analysis 4th ed. CHARLES D. GHILANI and PAUL R. WOLF.
  - Elementary Surveying, an introduction to Geomatics, 13th ed. CHARLES D. GHILANI and PAUL R. WOLF.
- Instruments manuals and field books.
- Lecture periods, Practical periods, & Consultation hours –
- Working individually or in pairs ?

Table of Contents

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- **Basic concept of Surveying (1st Semester)**
  - Definition – Basic measurements – Control networks – Locating position
- **Error and uncertainty (1st Semester)**
  - Units of measurement – Scale – Significant figures –– Errors in measurement – Indices of precision – Weight – Rejection of outliers – Combination of errors.
- **Distance measurement (1st Semester)**
  - Tapes – Field work – Distance adjustment – Errors in taping – Accuracies –Electromagnetic distance measurement (EDM) – Measuring principles – Meteorological corrections – Geometrical reductions – Errors, checking and calibration – Other error sources – Instrument specifications – Development in EDM.

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- **Vertical Control (1st Semester)**
  - Introduction – Levelling – Definitions – Curvature and refraction – Equipment – Instrument adjustment – Principle of levelling – Sources of error – Closure tolerances – Error distribution – Levelling applications – Reciprocal levelling – Precise levelling – Digital levelling – Trigonometrical levelling – vertical measurement with GPS.
- **Earthworks (1st Semester)**
  - Areas – Partition of land – Cross-sections – Dip and strike – Volumes – Mass-haul diagrams
- **Angle Measurement (2nd Semester)**
  - The theodolite – Instrumental errors – Instrument adjustment – Field procedure – Measuring angles – Sources of error.
- **Conventional control surveys (2nd Semester)**
  - Plane rectangular coordinates – Traversing – Triangulation – Networks.

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- **Curves (2nd Semester)**
  - Circular curves – Setting out curves – Compound and reverse curves – Short and/or small-radius curves – Transition curves – Setting-out data – Cubic spiral and cubic parabola – Curve transitional throughout – The osculating circle – Vertical curves.
- **Position (2nd Semester)**
  - Introduction – Reference ellipsoid – Coordinate systems – Local systems – Computation on the ellipsoid – Datum Transformations – Orthomorphic projection – The Universal Transverse Mercator Projection – Ordnance Survey National Grid – Practical applications.
- **Satellite positioning (2nd Semester)**
  - Introduction – GPS segments – GPS receivers – Satellite orbits – Basic principle of position fixing – Differencing data – GPS observing methods – Error sources. GPS survey planning – Transformation between reference systems – Datums.

History of Surveying

- The Early Days Of Surveying
  - Surveying has been around approximately 6000 years ago

    Monument Stonehenge may have included the use of surveyors, employing peg and rope geometry.



History of Surveying

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- The Early Days Of Surveying
  - 2700 BC by Egyptian

    Great Pyramid by using basic geometry.
  - 1400 B.C by Egyptian

    land division into plots for the purpose of taxation.
  - Romans were the Next

    an official land surveyor was employed by the empire

History of Surveying

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- The Early Days Of Surveying
  - 120 B.C
    - Greeks developed the science of geometry and were using it for precise land division.
    - Greeks developed the first piece of surveying equipment (Diopter).
    - Greeks standardized procedures for conducting surveys.

History of Surveying

- The Early Days Of Surveying
  - 1800 A.D.
  - Beginning of the industrial revolution.

    - "exact boundaries" importance.

    - demand for public improvements (i.e. railroads, canals, roads).

    - More accurate instruments were developed.

    - Science of Geodetic and Plane surveying were developed.

History of Surveying

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- Survey Today
  - To map the earth above and below the sea.
  - Prepare navigational maps (land, air, sea).
  - Establish boundaries of public and private lands.
  - Develop data bases for natural resource management.
  - Development of engineering data for
    - Bridge construction.
    - Roads.
    - Buildings.
    - Land development.

History of Surveying

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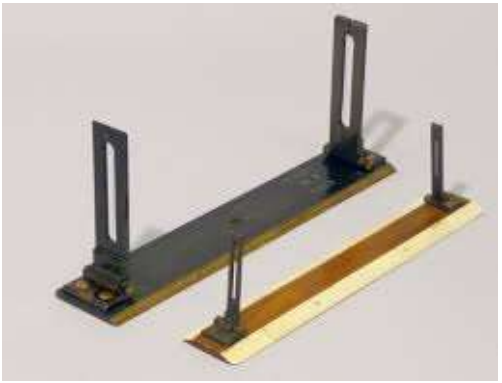
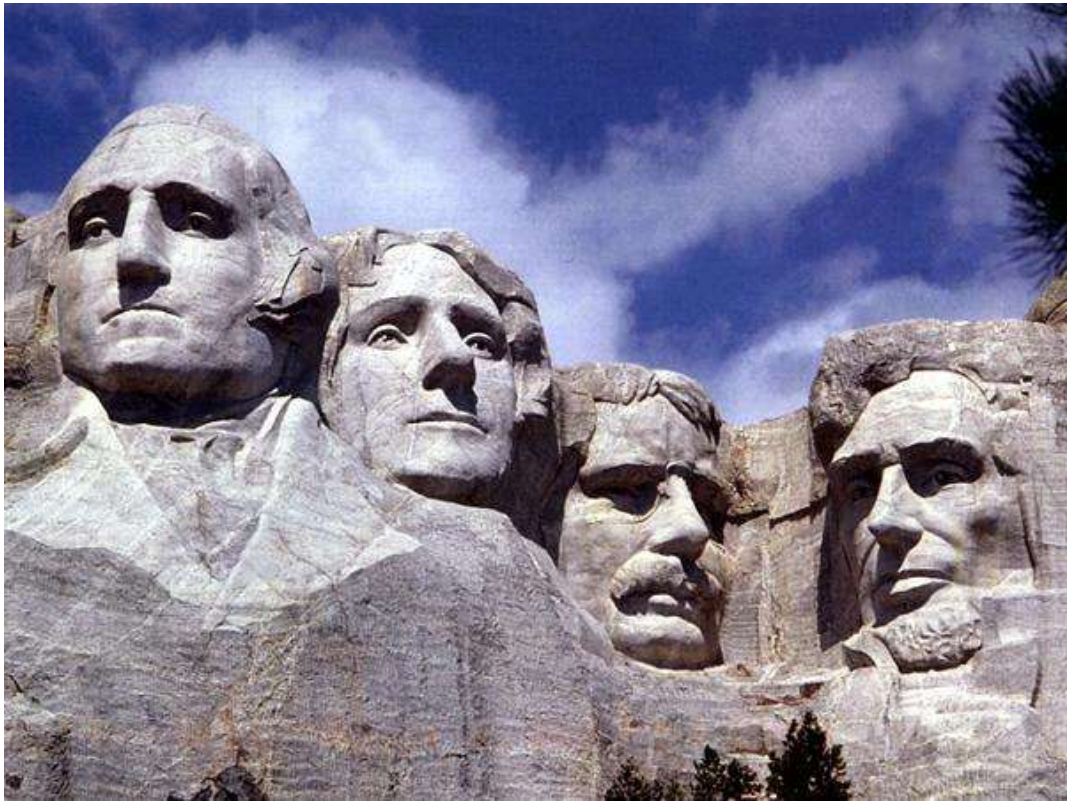
- Chain
- Compass
- Plane table
- Barometer
- Alidade



History of Surveying

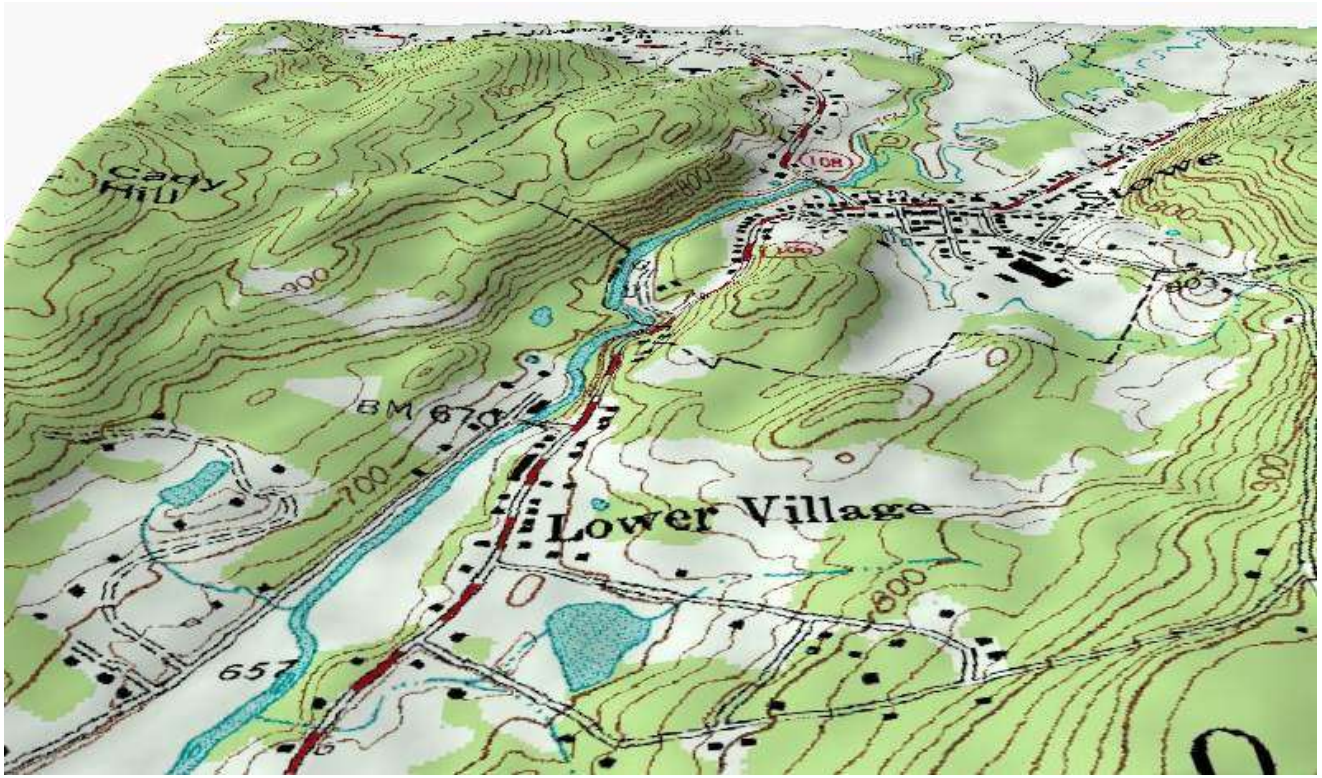
- Three of these four famous faces were surveyors
- Washington, Jefferson, and Lincoln



George Washington (1732–1799), Thomas Jefferson (1743–1826), Theodore Roosevelt (1858–1919), and Abraham Lincoln (1809–1865)

Purpose of Surveying

- To prepare a topographical maps.



Show both natural and man-made features

Purpose of Surveying

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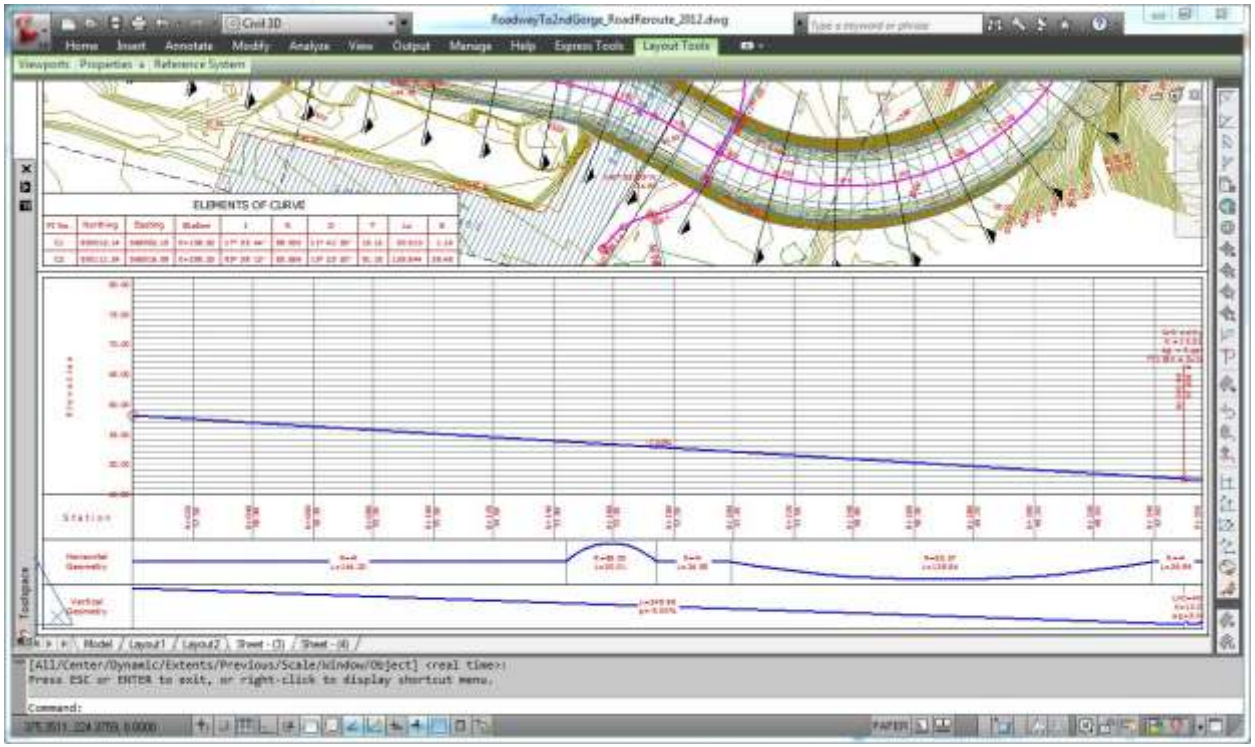
- To prepare the engineering detailed plans and sections of roads and other structures.



Purpose of Surveying

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- To determine the required areas and volumes of a land.

Purpose of Surveying

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- To ensure that the construction takes place in the correct relative and absolute position on the ground.

Purpose of Surveying

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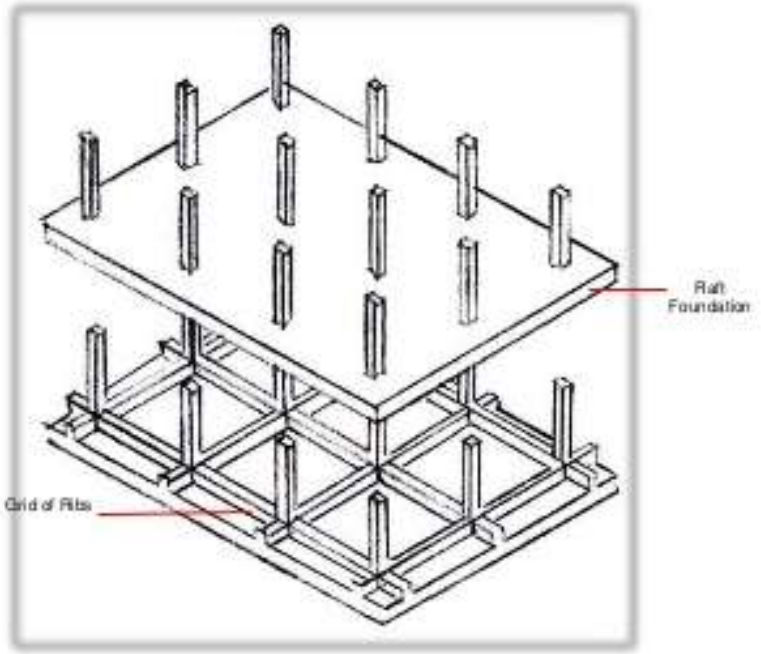
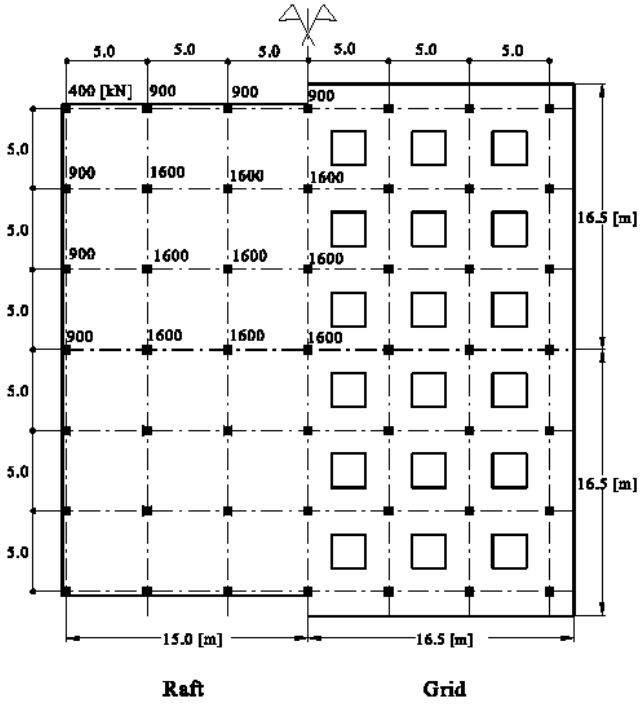
- To record the final position of the construction, including any design changes.





Purpose of Surveying

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- To provide permanent and temporary control points.

Purpose of Surveying

- To prepare a map of a country of detailed out location of cities, towns, villages and major roads.

Purpose of Surveying

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- To develop artificial vision, examples, an autonomous car or robot vacuum cleaner

Purpose of Surveying

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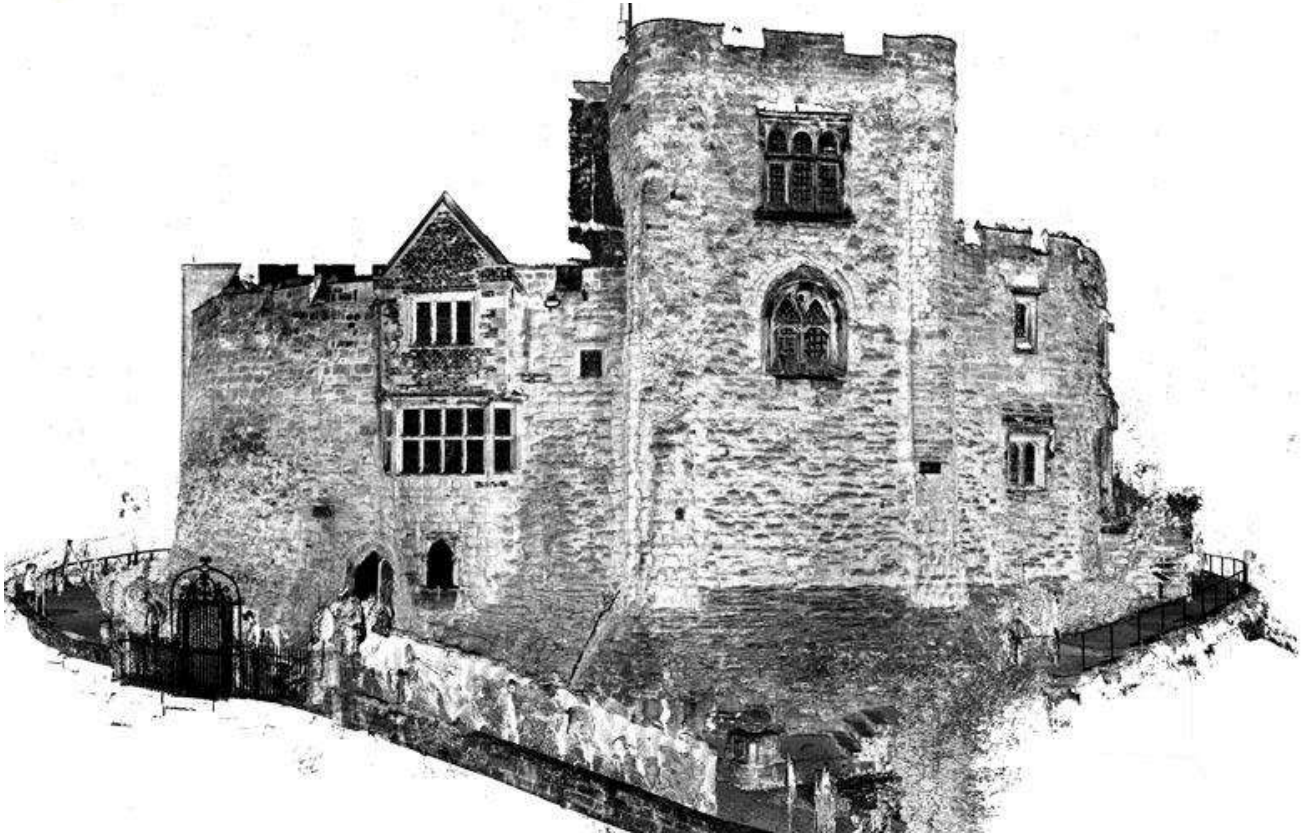
- To record archeological, crimes scenes



Basic concept of Surveying

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- Definition
  - The art of making measurements of the relative positions of natural and man-made features on the Earth's surface, and the presentation of this information either graphically or numerically.
  - surveying requires management and decision making in deciding the appropriate methods and instrumentation required to complete the task satisfactorily to the specified accuracy and within the time limits available.

Basic Measurement

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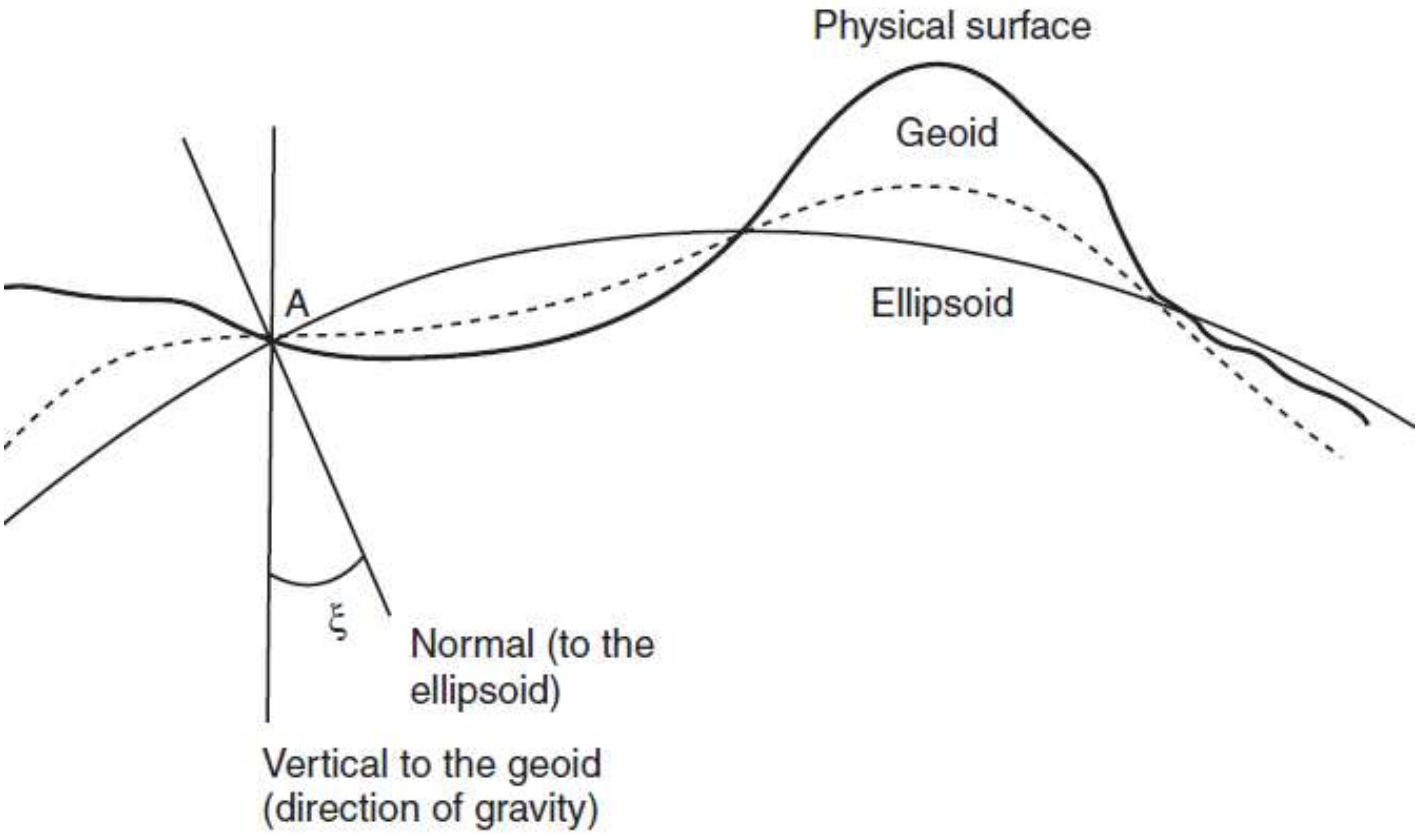
- Earth is not mathematically definable.
- Surface close to fit the mean position of the oceans called Geoid.
- Geoid is equipotential surface that most closely approximates to mean sea level (MSL).
- A level or equipotential surface through a point is normal to the direction of gravity (plumb line).
- Geoid, which although very smooth is still an irregular surface and so cannot be used to locate position mathematically.
- best is an ellipsoid formed by rotating an ellipse about its minor axis.

Basic Measurement



Geoid, ellipsoid and physical surface

Basic Measurement

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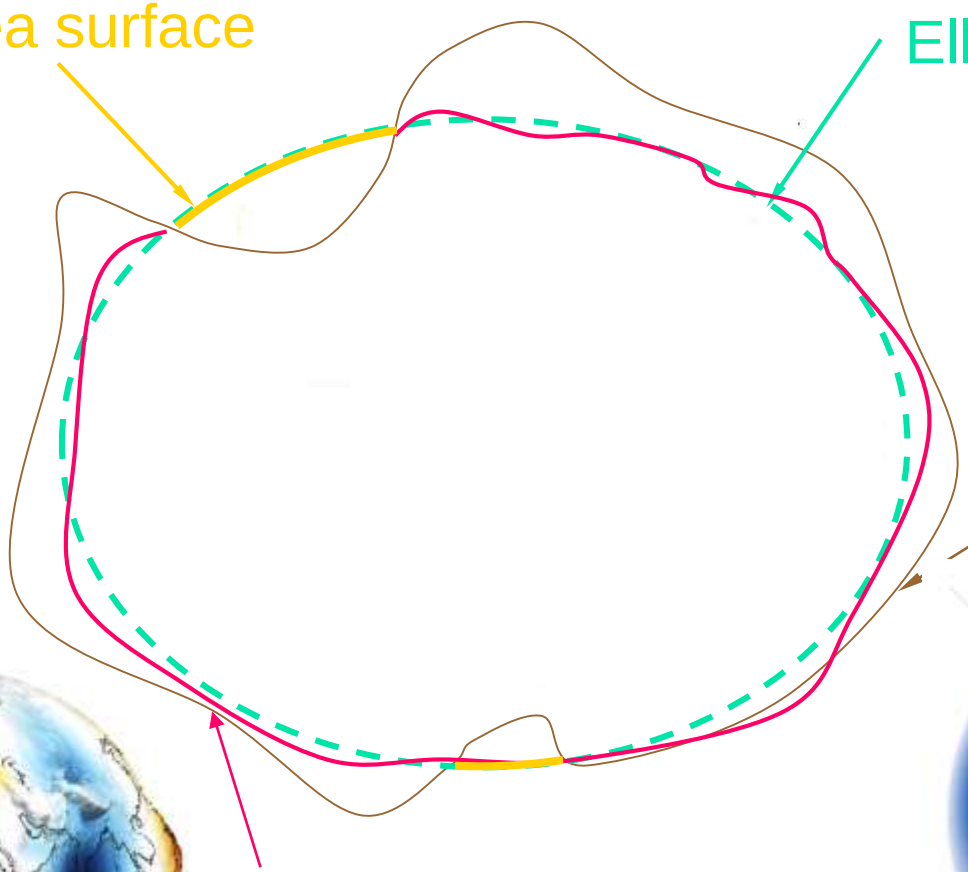

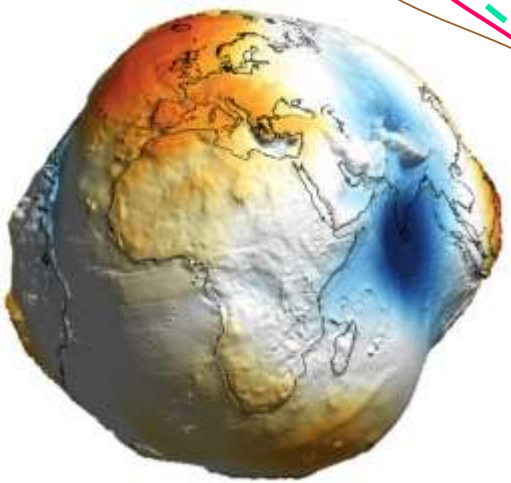

Basic Measurement

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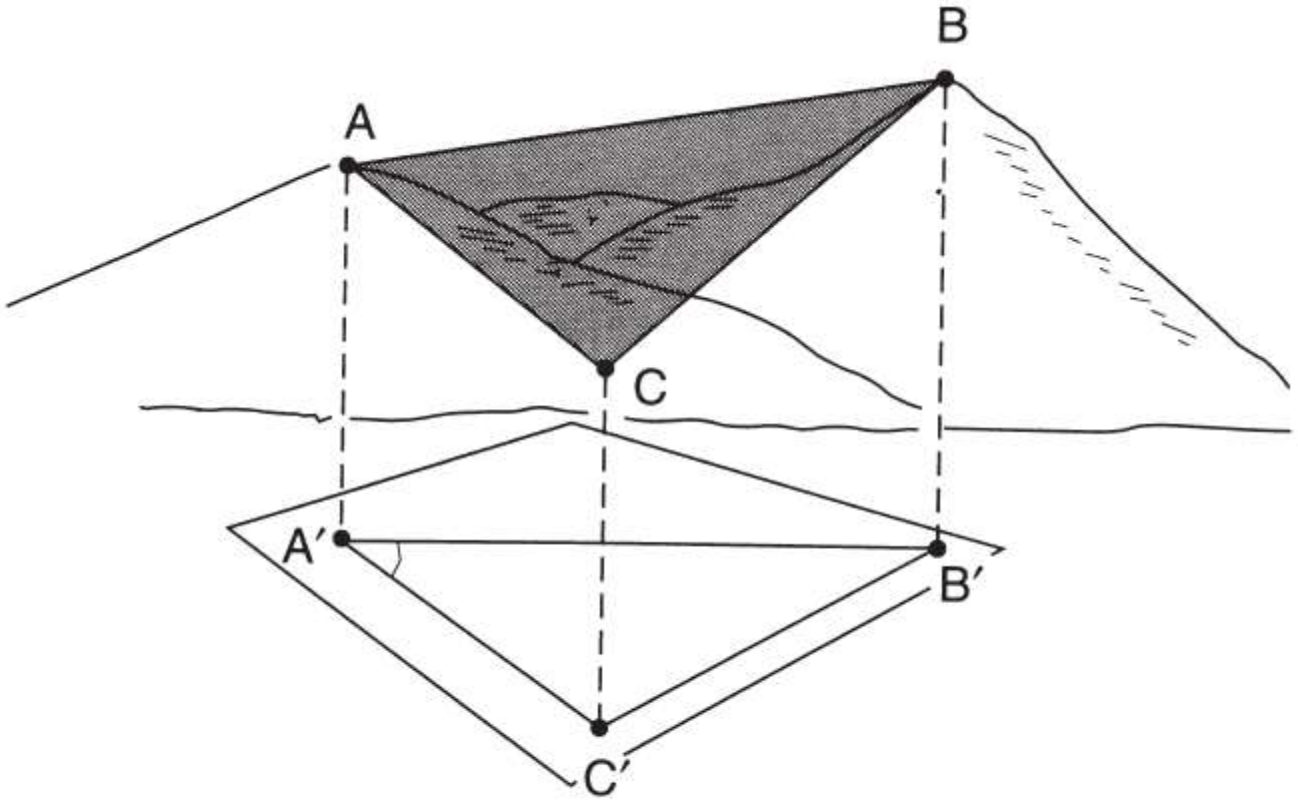
- Most engineering surveys are carried out in small areas.
- The reference surface may be taken tangent plane to the geoid, fig.
- For areas < 10 KM ^{2} Principle of plane survey is applied and curvature is neglected.
- Knowing that for 200 KM ^{2} , the difference between the sum of the spherical angles and the plane angles would = 1".
- Difference of 20 km Arc to its chord length is about 8mm.
- Above assumption is true for positional applications but not elevations.
- Cause geoid deviate from tangent plane by about 80 mm / 1 km.
- Or error due to earth curvature in elevation is about 80 mm / 1 km.

Basic Measurement



Projection onto a plane surface

Control Network

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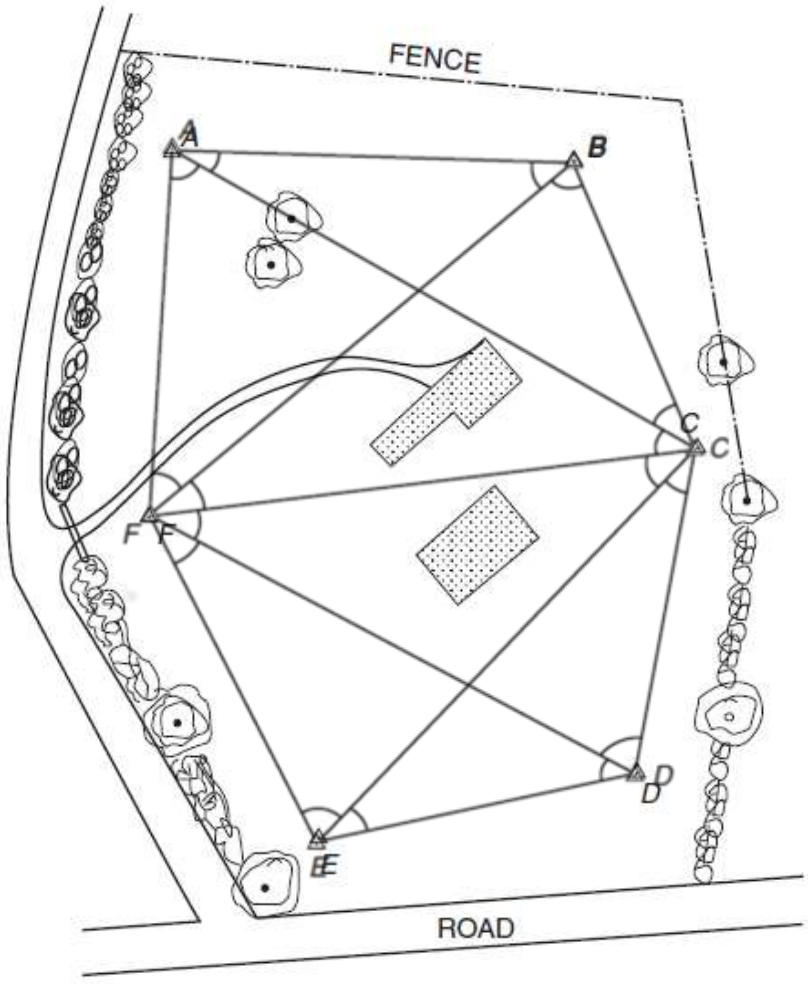
- A large or small areas of land require control network.
- Control network are series of control points for
  - topographic surveying
  - control
  - supplementary points, or
  - dimensional control on site.
- Projects require set out of structure to sub-cm accuracy.
- Design of survey stations for CPs based mainly on the time of project
- Long wooden peg with nail in middle and concrete around is enough for most construction projects.

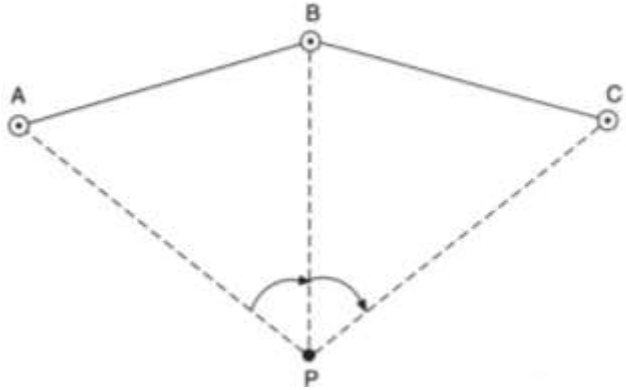
Control Network

- Possible procedures for CPs
  1) Reconnaissance.
  2) Structure of Survey station.
  3) Survey of CPs using one of the following:
     1) Intersection or resection
     2) Traversing
     3) Networks
     4) GPS satellites

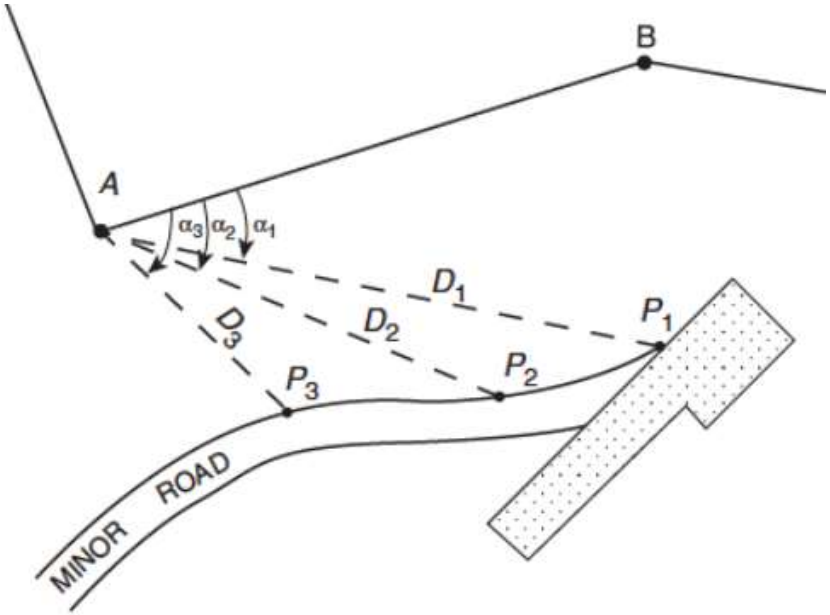


Locating position

- Positions of CPs could be known by polar coordinates (Total station) or by GPS.
- With total station (2 points should be known AB).
- If positions of all points in network known, then details survey starts.



Intersection



No check

Resection

Possible exam questions

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- What is the approximate date of first survey activity and where it was?
- Earth is _____ definable.
- What surface close to fit the mean position of the oceans called?
- Geoid is equipotential surface that most closely approximates to mean sea level (MSL). (TRUE or FALS).
- A level or equipotential surface through a point is normal to the direction of gravity (plumb line). (TRUE or FALS).
- Geoid is an irregular surface. (TRUE or FALS).
- Mathematical can be carried out on Ellipsoid. (TRUE or FALS).
- How model of earth ellipsoid is formed?
- Draw a diagram to show ellipsoid, geoid and physical earth.
- Most engineering surveys carried out in small areas (TRUE or FALS).

Possible exam questions

The University of Duhok

- In small area, what reference system could be taken for survey?
- For areas < 10 KM ^{2} Principle of plane survey is applied and curvature is neglected. (True or False)
- For areas of 200 km square, what is the sum difference between the spherical and plane angles?
- Prove mathematically that the difference of 20 km Arc of earth surface to its chord length is about 8mm.
- Prove that error due to earth curvature in elevation is about 80 mm / 1 km