وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الجنوبية
المعهد التقني العمارة
قسم تقنيات المساحة

الحقيبة التدريسية لمادة

1/ المساحة
Surveying/ 1
الصف الاول

تدريسي المادة
م . م احمد عبدالمنعم

الفصل الدراسي الاول

جدول مفردات مادة .مساحة 1

الاسبوع	المفردات
1	مقدمة عن المساحة وتعريفها وملخص للأعمال المختلفة التي تقدمها أقسام المساحة (المساحة المستوية، المساحة الجيوديسية) وتعريف كل منها شرح فرضيتي المساحة المستوية والجيوديسية، أنواع المساحة وفقاً للاستخدامات والأغراض التي تقدمها (المساحة الطوبوغرافية) الكادسترائية والتصويرية، المائية ومسح الطرق ومسح المناجم) تعيين موضع نقطة ما على الأرض، التوجيه وتعين نقطة على استقامة خط (أو على امتداده.(
2	وحدات القياس (وحدات الطول، المساحة، الحجم) في النظامين المتري (الفرنسي) والقدم (الانكليزي) التحول من وحدة إلى أخرى ضمن النظام الواحد، التحويل من نظام إلى أخر، قياس الزوايا بالنظام الستيني والمئوي والنصف قطري والتحويل من نظام إلى آخر حساب المساحة بنظام التسجيل العقاري (دونم، أولك، متر).
3	مقياس الرسم، أنواعه (المقياس العددي بنوعيه الكسري التمثيلي الهندسي). التحويل من صيغة الهندسي إلى الكسري وبالعكس المقياس التخطيطي (المقياس التخطيطي البسيط، المقياس الخطي المقارن، المقياس الشبكي) شرح تصميم المقياس التخطيطي، اختيار المقياس بموجب نوع المسح، حساب مقياس الرسم المناسب للرسم ومقياس الرسم المجهول بعدة طرق.
4	قياس المسافة على أرض منبسطة (مستوية وغير مستوية)، دقة القياس الحقلي (الدقة النسبية)، الدقة التصميمية)، اختيار طريقة القياس بموجب الدقة المطلوبة ممثلة بجدول (من الكتاب المنهجي) المقارنة بين صيغة تمثيل الدقة وبين صيغة المقياس الكسري للقياس غير المباشر لحساب المسافة بدلالة أضلاع مقاسة أخرى.
5	قياس المسافة على أرض مائلة (منتظمة الميل، غير منتظمة الميل، تصحيح المسافة المائلة إلى ألأفقية عندما يكون الميل بدلالة (زاوية الارتفاع أو الانخفاض، الفرق في المنسوب بين طرفي خط القياس النسبة المئوية للميل أو الانحدار، مقدار تدرج الأرض)). قياس المسافة على سطح مائل بشريط في وضع أفقي، طرق تصحيح المسافة المائلة الأفقية (باستخدام النسب المثلثية، طريقة المثلث القائم، طريقة النسبة والتناسب، واستخدام مفكوك متسلسلة القوى للتصحيح للارتفاع (حد واحد أو حدين حسب الدقة.(
6	بعض العمليات الهندسية التي تجري أثناء القياس بالشريط وتشمل إقامة الأعمدة من النقاط على خط السير، إنزال أعمدة من نقاط خارجية من خط السير، تعيين الموازي لخط السير.
7	العقبات المحتلمة أثناء قياس المسافة:
8	عقبات التوجيه عدم رؤية البداية والنهاية من نقطة وسطية.
9	عقبات القياس (عندما يكون الالتفاف حول العارض الممتد).
10	عقبات التوجيه والقياس.
11	مسح تفاصيل المنطقة (المضلع والتحشية) باستخدام الشريط، رسم المضلع (توزيع خطأ القفل المقبول بالطريقة الترسيمية والرياضية، رسم التفاصيل على المضلع المصحح).
12	التسوية، تعاريف المصطلحات الأساسية (الخط المستوي السطح المستوي، الخط الأفقي، مستوى المقارنة، متوسط مستوى سطح البحر، المنسوب، راقم التسوية، وأنواعه، ظاهرة اختلاف النظر توضيح صورة الهدف، خط النظر، المحور البصري، خط الانطباق، خط الشاقول، ارتفاع جهاز التسوية، فرق المنسوب، القراءة الخلفية، القراءة الأمامية، قراءة النقطة الوسطية، نقطة الدوران أو التحويل، تعاريف ضرورية أخرى، أنواع التسوية، التسوية المباشرة (بواسطة الشريط أو بواسطة جهاز التسوية).
13	الغرض من التسوية، درجات الدقة، جهاز التسوية، أنواعه، أجزاءه، نصب جهاز التسوية، أنواع مساطر التسوية، قراءة مسطرة التسوية، حساب فرق المنسوب بين نقطتين، حساب منسوب نقطة مجهولة بدلالة نقطة معلومة، طرق التسوية، الطريقة التفاضلية، تعريفها، خطوات العمل، طرق الحساب (طريقة ارتفاع الإجهاز).
14	تكملة طرق الحساب (طريقة الارتفاع والانخفاض)، المقارنة بينهما، جدول التسوية، التحقيق الحسابي للجدول، الأخطاء المحتملة في عملية التسوية، طرق تدقيق العمل الحقلي (إنهاء عملية التسوية على نقطة بدء العمل، إنهاء عملية التسوية على نقطة معلومة أخرى).
15	خطاء الغلق الرأسي، الخطأ المسموح به، تصحيح مناسيب خطأ الغلق الرأسي بنسبة بعد نقطة الدوران عن البداية، تأثير كروية الأرض والانكسار على قراءة المسطرة، التحقق من صلاحية الجهاز للعمل بطريقة الوتدين.

الهدف من دراسة مادة المساحة 1 (الهدف العام):

تهدف دراسة مادة المساحة 1 للصف الاول الى:

1) يفهم الطالب أساسيات المساحة المستوية .
2) ايجاد العلاقة بين موقع النقاط قرب أو فوق سطح الارض وأن يكون قادرا على قياس المسافة الافقية والرأسية للهدف المرصود.
3) وحساب المساحات والحجوم من البيانات الحقلية وحصول الطالب على معلومات في رسم الخرائط التي تبين المقاطع الطولية والعرضية للطرق والقنوات واعداد الخرائط الكنتورية .

الفئة المستهدفة:

طلبة الصف الاول / قسم تقنيات المساحة

التقنيات التربوية المستخدمة:

1. سبورة واقلام
2. السبورة التفاعلية
3. عارض البيانات Data Show
4. جهاز حاسوب محمول Laptop
5. .....
6. ....
7. .....

Surveying is the art of determining the relative positions of distinctive features on the surface of the earth or beneath the surface of the earth, by means of measurements of distances, directions and elevations. The branch of surveying which deals with the measurements of relative heights of different points on the surface of the earth, is known as *levelling.*

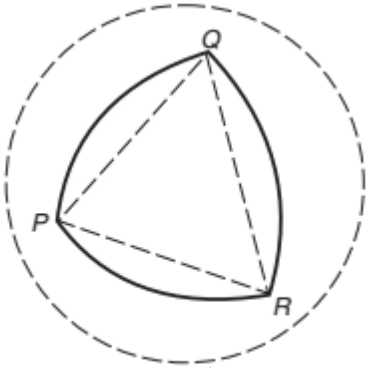
OBJECT OF SURVEYING the object of surveying is the preparation of plans and maps of the areas.

PRIMARY DIVISIONS OF SURVEYING The surveying may primarily be divided into two divisions:

1. Plan surveying, 2. Geodetic surveying

1. **Plan Surveying.** The surveys in which earth surface is assumed as a plane and the curvature of the earth is ignored, are known as *Plane surveys.* As the plane survey extends only over small areas, the lines connecting any two points on the surface of the earth, are treated as straight lines and the angles between these lines are taken as plane angles. Hence, in dealing with plane surveys, plane geometry and trigonometry are only required. Surveys covering an area up to 260 sq. km may be treated as plane surveys because the difference in length between the arc and its subtended chord on the earth surface for a distance of 18.2 km, is only 0.1 m.

2. **Geodetic Surveying.** The surveys in which curvature of the earth is taken into account and higher degree of accuracy in linear as well as in angular observations is achieved, are known as *'Geodetic Surveying'.* In geodetic surveying, curvature of the earth's surface is taken into account while making measurements on the earth's surface. As the surveys extend over large areas, lines connecting any two points on the surface of the earth, are treated as arcs. For calculating their projected plan distances for the plotting on the maps, the curvature correction is applied to the measured the angles between the curved lines are treated as spherical angles. A knowledge of spherical trigonometry is necessary for making measurements for the geodetic surveys.



CLASSIFICATION OF SURVEYS

According to the use and the purpose of the final maps, surveys may be classified, under the following different heads:

1- **Classification based upon the nature of the field**

1-Land Surveys. These include the following:

(i) **Topographic surveys.** The surveys which are carried out to illustrate the topography of the mountainous terrain, rivers, water bodies, wooded areas and other cultural details such as roads, railways, townships etc., are called *topographical surveys.*

(ii) (*ii*) **Cadastral surveys.** The surveys which are generally plotted to a larger scale than topographical surveys and arc carried out for fixing the property lines, calculation of area of landed properties and preparation of profits maps of states, are called *cadastral survey.* These are also sometimes used for surveying the boundaries of municipalities, companies and cantonments.

(iii) (*iii*) **City surveys.** The surveys which are carried out for the construction of roads, parks, water supply system, sewer and other constructional work for any developing township, are called *City surveys.* The city maps which are prepared for the tourists are known as *Guide Maps.*

2. Hydrographic Surveys. The surveys which deal with the mapping of large water bodies for the purpose of navigation, construction of harbour works, prediction of tides and determination of mean sea-level, are called *Hydrographic surveys.* Hydrographic surveys consist of preparation of topographical maps of the shores and banks, by taking soundings and determining the depth of water at a number of places and ultimately surveying bathymetric contours under water.

3. Astronomical Surveys. The surveys which are carried out for determining the absolute locations *i.e.*, latitudes of different places on the earth surface and the direction of any line on the surface of the earth by making observations to heavenly bodies, *i.e.,* stars and sun, are called *astronomical surveys.* In nothern hemisphere, when night observations are preferred to, observations are usually made to the Polaris, *i.e.,* the pole star.

2- **Classification based on the purpose of the survey**

1. **Engineering Surveys.** The surveys which are carried out for determination of quantities or to provide sufficient data for designing engineering works, such as roads, reservoirs, sewage disposal, water supply, etc., are called *Engineering Surveys.*
2. **Military or Defense Surveys.** The surveys which are carried out for preparation of maps of the areas of Military importance, are called *military surveys.*
3. **Mine Surveys.** The surveys which are carried out for exploration of mineral wealth beneath the surface of the ground, *i.e.,* coal, copper, gold, iron ores etc., are called *Mine surveys.*

4. **Geological Surveys.** The surveys which are carried out to discover the composition of the earth crust *i.e.*, different layers' of rocks of the earth crust, are called *Geological surveys.*
5. **Archaeological Surveys.** The surveys which are carried out to prepare maps of ancient culture *i.e.*, antiquities, are called *Archaeological surveys.*

3- **Classification based on instruments used**

According to the instruments used and method of surveying, the surveys may also be classified as under:

1. Chain surveying
2. Compass surveying
3. Plane table surveying
4. Theodolite surveying
5. Tachometric surveying
6. Triangulation surveying
7. Aerial surveying
8. Photogrammetric surveying

Distance measurement

Horizontal Distances Are Measured

(1) Spacing or Stepping Method:

*Total distances = no. of paces * length space*

(2) Tapes Method:

Taping is a direct measurement of distance, there are many Kinds tapes *(Cloth tape, steel tape, metallic linen tape)*

Additional tools used in measurement

1- Ranging poles (Range rod)

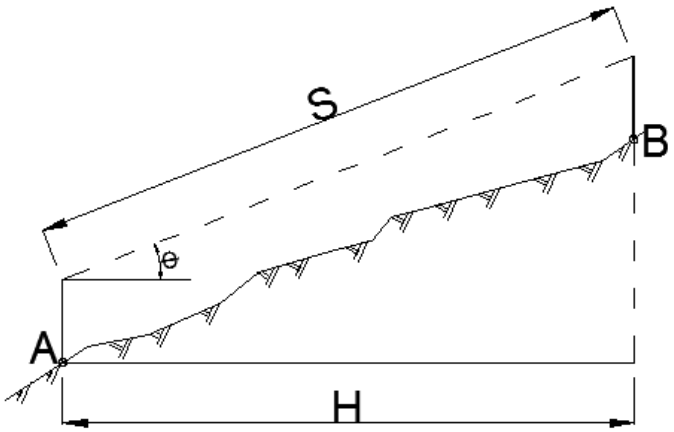
2- pins or arrow

3- Pegs

Measuring distance by tape

(1) *Slope taping*: - The tape is hold as required by the slope of the ground, the slope of the tape is measured and the horizontal distance is computed.

(2) *Horizontal taping*: - The tape is hold horizontal and the required graduation is projected to the ground with plumb - bob (or spirit level).



(Case I): - When the distance between two stations is less than length of the tape, so the determining of distance should be found directly.
(Case II): - When the distance between two stations is more than length of the tape, in this case we need range poles in the start and end stations also range pole and pins in intermediate stations, then measure the distance between each two pigs to the end of line.

M = N * L + G

M = total distance L = tape length
N = no. of pins G = rest part of tape

Example: -

During Spacing or stepping method if (no. of pin = 10) (rest part of tape = 9.75 m), length 50 m
Find the total distance (M)

sol

M = N * L + G
M = 50 * 10 + 9.75 = 509.75 m

Correction For Distances

(1) Correction for Length of the Tape.

(2) Correction for Slope of the Earth.

(3) Correction for Temperature.

(4) Correction for Sag.

(5) Correction for Tension or Pull.

(6) Correction for Above or Below Means Sea Level.

(7) Correction for Slope of the Earth and Inclined of the Tape.

1. Correction for length of the tape: -

The tape may be too long or too short with respect to the stander length in both cases correction must be due by using the formula.

$D_0 = D * L / L_0$

D_0 = true distance need it.

D = field distance measured.

L = field tape length.

L_0 = standard tape length.

Note: -

When $L > L_0$ $D_0 > D$

When $L < L_0$ $D_0 < D$

Example: -

20 m tape which was 20 cm too short, was used to measure a line AB and the result was (196.1 m), What was the true length of line AB?

SOL

L = 20 – 0.20 = 19.80 m (field tape length).

D0 = D * L /L0 = 196.1 * 19.80 / 20 = 194.139 m.

2. Correction for slope of the earth (C_S): -

This correction is applied because the length on a slope is not the same as the distance projected on a horizontal plane.

{ Case I }:- When L and θ was known.

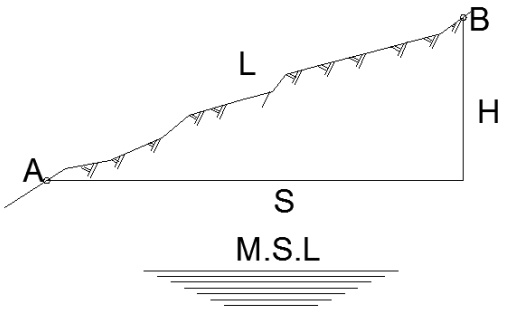
cos θ = S / L S = L cos θ

L > S, $L - C_s = S$

$Cs = L - S$

Cs = L – L cos θ, L (1- cos θ)

Cs = L (1 - cos θ)



Example: -

Two lines are measured on a slope equal to (100 m) length each and the slope (1/12, 1/20). Fined the horizontal distance in each?

sol

Slope1 = tan θ1 = 1 / 12 θ1 = tan- 1 (0.0833) = 4.763 0 < 8 ^{0}

Slope2 = tan θ2 = 1 / 20 θ2 = tan- 1 (0.05) = 2.862 0 < 8 ^{0}

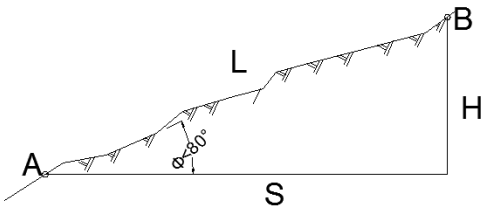
Cs = L (1 - cos θ1) = 100 (1 – cos 4.763) = 0.345 m

S = L – Cs = 100 – 0.345 = 99.655 m

Cs = L (1 - cos θ2) = 100 (1 – cos 2.862) = 0.124 m

S = L – Cs = 100 – 0.124 = 99.876 m

(Case II): - when L and h are known.
When slope <= 14 % or θ^0 <= 8^0
L = S L, $L^2 = h^2 + s^2$, $h^2 = L^2 - s^2$
$\boldsymbol{C_s = h^2 / 2L}$



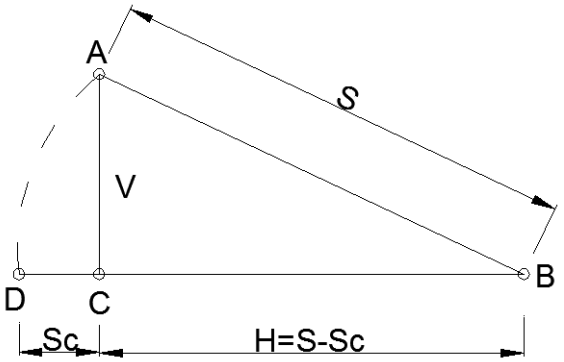
When slope > 14 % or $\theta^0 > 8^0$
$\boldsymbol{C_s = h^2 / 2L + h^4 / 8h^8}$

Example:
A line ab (2260.65 m) along constant slope the difference in elevation between two ends of the line is (85. 96) m.
What is the horizontal length of the line ab?
Sin θ = 85.96 / 2260.65 = 0.038 θ = Sin -1 0.038 = 2.179 0 < 8^0
Cs = h 2 / 2L = (85.96)2 / 2 * 2260.65 = 1.634
S = L – Cs = 2260.65 – 1.634 = 2259.01 m.

Measurement On Sloping Grounds:

1. measurement on regular sloping grounds

a) by measure the vertical distance between the two ends of the inclined



$S^2 = V^2 + H^2$

$S^2 = V^2 + (S - S_C)^2$

$$\mathbf{S_C = \frac{V^2}{2S} + \frac{V^4}{8S^3}}$$

Example:

Measure the length of the slope and it was 30m, the vertical distance it was 12m, find the correction distance and find the horizontal distance.

Sol:

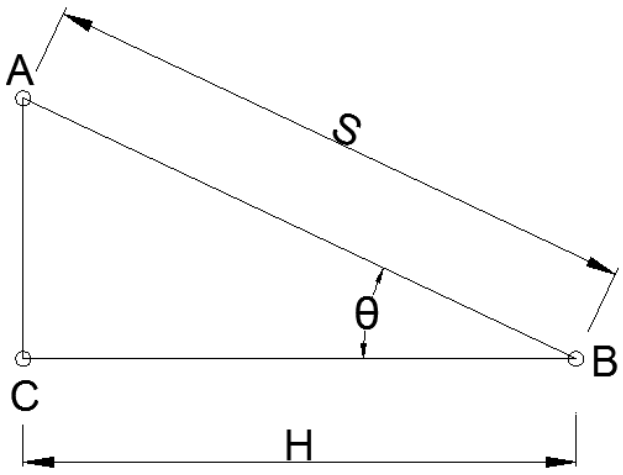
$$S_C = \frac{V^2}{2S} + \frac{V^4}{8S^3}$$

$$S_C = \frac{12^2}{2(30)} + \frac{12^4}{8(30)^3} = 2.496 \text{ M}$$

H = S - S_C = 30 – 2.496 = 27.04 M

b) Ground angle measure

The angle between the horizontal line and the ground may be measured by using clinometer or theodolite instruments.



* Theoretical method H=S cos θ
* approximate method S_C=(0.00015 θ^2)S
H=S-S_C

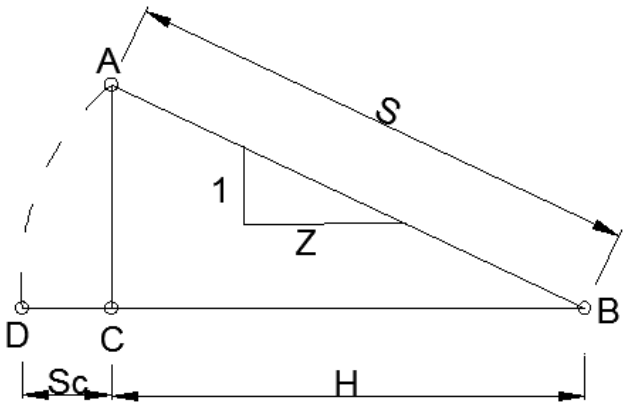
Example:

S=20m, θ=10

Theoretical method H=S cos θ=20*cos10=19.696 m

approximate method S_C=(0.00015 θ^2)S=(0.00015*10^2)*20=19.70m

c) If the slope of the ground is known



Approximate equation $S_C = \frac{S}{2Z^2}$

H=S-S_C

Example:

Measure The Length Of The Slope And It Was 100m, With Slope 1/4 Find The Horizontal Distance.

Sol:

Approximate equation

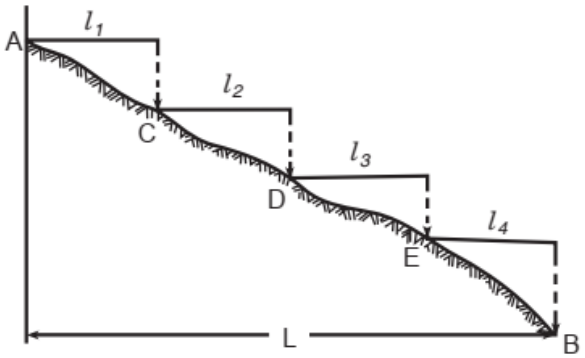
$S_C = \frac{S}{2Z^2}$

$S_C = \frac{100}{2(4)^2} = 3.125$ m

H=S-S_C = 100 - 3.125 = 96.875 m

2. measure horizontal distance on slope ground (Position the tape horizontally) is called direct measure:

L=l1+l2+l3+l4



Stepping method.

GEOGRAPHICAL SURVEY

The following technical terms are generally used in surveying:

1. **Plan.** A plan is the graphical representation of the features on the earth surface or below the earth surface as projected on a horizontal plane. This may not necessarily show its geographical position on the globe. On a plan, horizontal distances and directions are generally shown.

2. **Map.** The representation of the earth surface on a small scale, is called a *map*. The map must show its geographical position on the globe. On a map the topography of the terrain, is illustrated generally by contours, hachures and spot levels.

3. **Topographical map.** The maps which are on sufficiently large scale to enable the individual features shown on the map to be identified on the ground by their shapes and positions, are called *topographical maps.*

4. **Geographical maps.** The maps which are on such a small scale that the features shown on the map are suitably generalized and the map gives a picture of the

country as a whole and not a strict representation of its individual features, are called *Geographical maps.*

PRINCIPLE OF SURVEYING

The fundamental principles upon which different methods of surveying are based, are very simple. These are stated as under:

1. **Working from the whole to the part.** The main principle of surveying whether plane or geodetic is to work from the whole to the part. To achieve this in actual practice, a sufficient number of primary control points, are established with higher precision in and around the area to be detail-surveyed. Minor control points in between the primary control points, are then established with less precise method. Further details are surveyed with the help of these minor control points by adopting any one of the survey methods. The main idea of working from the whole to the part is to prevent accumulation of errors and to localize minor errors within the frame work of the control points. On the other hand, if survey is carried out from the part to the whole, the errors would expand to greater magnitudes and the scale of the survey will be distorted beyond control. In general practice the area is divided into a number of large triangles and the positions of their vertices are surveyed with greater accuracy, using advanced instruments. These triangles are further divided into smaller triangles and their vertices are surveyed with lesser accuracy.

2. Location of a point by measurement from two control points.

The control points are selected in the area and the distance between them, is measured accurately. The line is then plotted to a convenient scale on a drawing sheet. In case, the control points are coordinated, their locations may be plotted with the system of coordinates, *i.e.,* Cartesian or spherical. The location of the required point may then be plotted by making two measurements from the given control points as explained below.

Let *P* and *Q* be two given control points. Any other point, say, *R* can be located with reference to these points, by any one of the following methods (Fig.1.2).

(*a*) *By measuring the distances PR and QR.* The distances *PR* and *QR* may be measured and the location of *R* may be plotted by drawing arcs to the same scale to which line *PQ* has been drawn [Fig.1.2 (*a*)].

(*b*) *By Dropping a perpendicular from R on PQ.* A perpendicular *RT* may be dropped on the line *PQ*. Distances *PT*, *TQ* and *RT* are measured and the location of *R* may be plotted by drawing the perpendicular *RT* to the same scale to which line *PQ* has been drawn [Fig. 1.2 (*b*)]. Principles (*a*) and (*b*) are generally used in the method of 'Chain surveying

(*c*) *By measuring the distance QR and the angle PQR.* The distance *QR* and the angle *PQR* equal to ⟨ are measured and the location of *R* may be plotted either by means of a protractor or trigonometrically [Fig.1.2 (*c*)]. This principle is used in the method of '*Theodolite Traversing'.*

(*d*) *By measuring the interior angles of the triangle PQR*. The interior angles *P, Q* and *R* of the triangle *PQR* are measured with an angle measuring instrument such as theodolites. The lengths of the sides *PR* and *QR* are calculated by solving the triangle *PQR* and the coordinates of *R* are calculated in the same terms as those of *P* and *Q*. Even without calculating the coordinates, or sides the location of *R* can be obtained by plotting the angles *PQR* and *QPR* [Fig. 1.2 (*d*)]. This principle is used in the method of 'Triangulation'.

(*e*) *By measuring the sides of the triangle PQR.* The interior angles *P*, *Q* and *R* are calculated from the measured sides of the triangle *PQR* by applying cosine rule. This principle is used in the method of Trilateration.

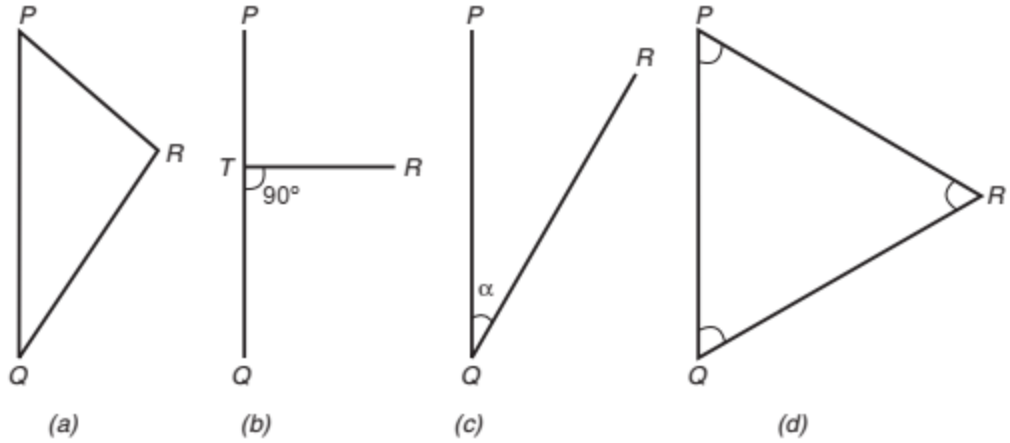


Fig.1.2. Location of a point.

UNITS OF MEASUREMENTS

There are two kinds of measurements used in plane surveying;
1. Linear measure, *i.e.*, horizontal or vertical **distances.**
2. Angular measure, *i.e.,* horizontal or vertical **angles.**

1. Linear Measures.

The units of measurement of distances, have been recommended as meter and centimeter for the execution of surveys.

(a) Basic units of length in metric system:

10 millimeters= 1 centimeter
10 centimeters = 1 decimeter
10 decimeters = 1 meter
10 meters = 1 decameter
10 decameters = 1 hectometer
10 hectometers = 1 kilometer

(b) Basic units of area in metric system:

100 sq. meters = 1 are
2500 sq. meters = 1 *don*
10000 sq. meters = 1 hecta
4 don=1 hecta

(c) Basic units of volume in metric system:

1000 cub. millimeters = 1 cub. centimeter
1000 cub. centimeters = 1 cub. decimeter
1000 cub. decimeters = 1 cub. meter.

Before 1956, F.P.S. (Foot, pound, second) system was used for the measurement of lenghts, areas and volumes. These units which are known as British units, are:

(a) Basic units of length in F.P.S. System:

12 inches = 1 foot 3 feet = 1 *yard*

(*b*) *Basic units of area in F.P.S. System:*

144 sq. inch = 1sq. foot

Conversion Factors for Lengths

(Metres, yards, feet and inches)

Metres	*Yards*	*Feet*	*Inches*
1	1.0936	3.2808	39.37
0.9144	1	3	36
0.3048	0.3333	1	12
0.0254	0.0278	0.0833	1

Conversion Factors for Areas

(Sq. metres, sq. yards, sq. feet and sq. inches)

Sq. metres	*Sq. yards*	*Sq. feet*	*Sq. inches*
1	1.196	10.7639	1550
0.8361	1	9	1296
0.0929	0.1111	1	144
0.00065	0.00077	0.0069	1

Conversion Factors for Areas

(Ares, acres and sq. yards)

Ares	*Acres*	*Sq. metres*	*Sq. yards*
1	0.0247	100	119.6
40.469	1	4046.9	4840
0.01	0.000247	1	1.196
0.0084	0.00021	0.8361	1

Conversion Factors for Volumes

(Cub. metres, cub. yards, gallons)

Cub. metres	*Cub. yards*	*Gallons (Imps)*
1	1.308	219.969
0.7645	1	168.178
0.00455	0.00595	1

2. **Angular Measures.** An angle may be defined as the difference in directions of two intersecting lines, or it is the inclination of two straight lines. The unit of a plan angle is 'radian'. Radian is defined as the measure of the angle between two radius of a circle which contain an arc equal to the radius of the circle [Fig. 1.3].

The popular systems of angular measurements, are:
(*i*) *Sexagesimal System of Angular Measurements* In this system the circumference of a circle,
is divided into 360 equal parts, each part is known as *one degree.* 1/60th part of a degree is called *a minute* and 1/60th part of a minute, is called a *second. i.e.*
1circumference = 360 degrees of arc
1° = 60 minutes of arc
1 minute = 60 seconds of arc
(*ii*) *Centesimal System of Angular Measurements* In this system, the circumference of a circle,
is divided into 400 equal parts, each part is known as *one grad.* One hundredth part of a grad is known *as centigrad* and one hundredth part of a centigrad is known as *centi-centigrad i.e.,*
1 circumference = 400 grads
1 gard = 100 centigrads
1 centigrad = 100 centi–centigrads.

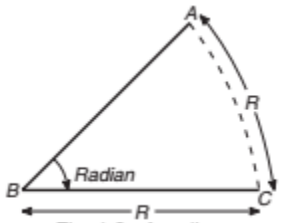


Fig. 1.3. A radian.

1- Unit of length

1km = 1000 m	1yard = 3ft	1mile = 5280 ft
1m = 10 dec	1ft = 12 inch	1mile = 1.6093 km
1dec = 10 cm	1inch = 2.54 cm	1ft = 0.3048 m

2- Unit of area

1 KM^2 = 100 hectar
100 hectar = 400 dounm
1dounm = 2500 m^2
1olk = 100 m^2

3- Unit of volume

$1\ cm^3 = 1000\ mm^3$

$1\ cm^3 = 1000\ dec^3$

$1\ dec^3 = 1000\ cm^3$

$1\ letter = 1000\ cm^3$

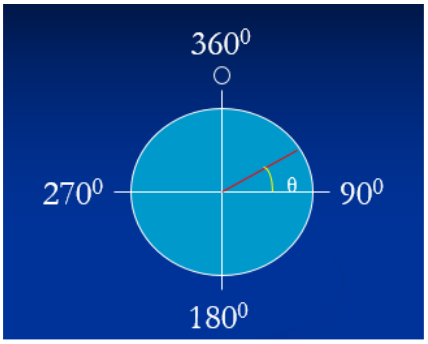
$1\ yard^3 = 0.7645\ m^3$

$1\ ft^3 = 0.02831\ m^3$

4- Unit of the angle

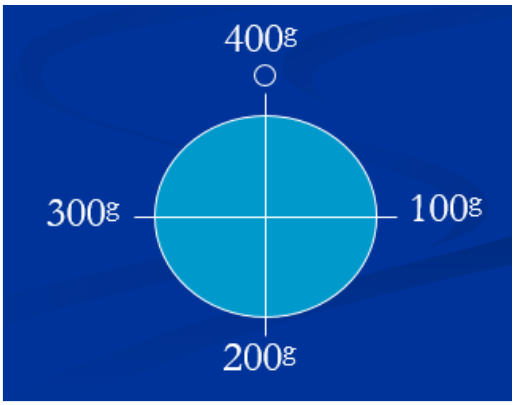
A) Degree system: -

circle perimeter = 360^0 degree
1^0 degree =$60'$ minutes
1^0 minutes = $60''$ seconds



B) Grade system

circle perimeter =400^g
1^g grade =100^c centigrade
100^ccentigrade =100^{cc} cent centigrade



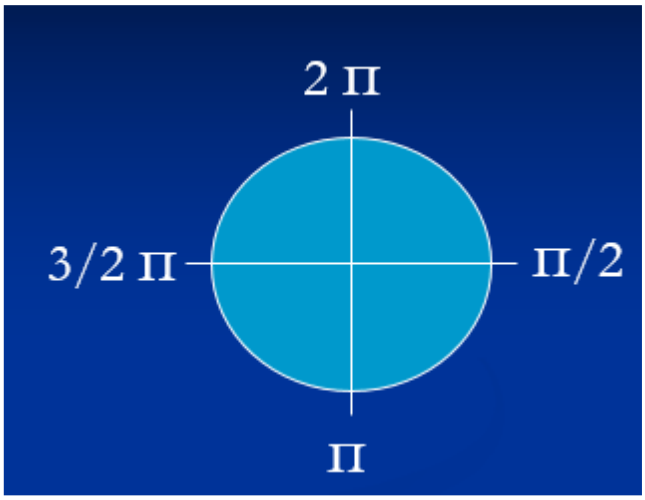
C- Radian system: -

It's the central angle which is the arch length to the radian

Θ = L/R= Radian

R.A(right angle) = π/2

π = 3.14



Example (1): -

Convert the angles 42° 26′ 30″, 72ᵍ 62ᶜ 35ᶜᶜ to the radian system.

Ans:-

42° 26 ′30″ = (42° + 26/60 + 30/60*60) * π/1800 = 0.74

72ᵍ 62ᶜ 35ᶜᶜ = {(72 + 62/100 + 35/100*100) * 3600/400} *π/1800=1.14R

H.W

Convert the angle 142° 22 ′ 14.5′ ′ to the grade system.

MAP SCALES

Considering the actual surface dimensions, drawings are made to smaller scale of the area. It is never possible to make its drawing to full size. This operation is generally known as *'drawing to scale'*

Scales of the maps are represented by the following two methods:
(*i*) Numerical scales.
(*ii*) Graphical scales.

1. Numerical scales. Numerical scales are further divided into two types, *i.e.*,
(a) Engineer's scale (*b*) Fraction scale.

(*a*) *Engineer's scale*. The scale on which one cm on the plan represents some whole number of meters on the ground, is known as *Engineer's scale.*
For example, 1 cm = 5 m; 1 cm = 10 m, etc.

(*b*) *Fraction scale***.** The scale on which an unit of length on the plan represents some number of the same unit of length on the ground is known as *Fraction Scale.*

For example, 1: 500; 1: 1000; 1: 5,000, etc.
To convert an engineer's scale into fraction scale, multiply the whole number of meters by 100. Similarly, a fraction scale may be converted into engineer's scale by dividing the denominator by 100 and equating the quotient to 1 cm.

Example 1.1. *The engineer's scale of a drawing, is stated to be 1 cm= 4 m. Convert this to fraction scale.*

Solution.
Engineer's scale is 1 cm = 4 m Fraction scale is 4 · 100 *or* 1: 400.

Example 1.2. *The fraction scale of a map is stated to be 1: 50,000. Convert this to Engineer's scale.*

Solution.
1 unit on plan = 50,000 units on the ground
1 cm on plan = 50,000 cm on the ground
or 1 cm on plan = 500 m on the ground
Engineer's scale is 1 cm = 500 m. Ans.

2. *Graphical scales***.** A graphical scale is a line subdivided into plan distances corresponding to some convenient units of length on the surface of the earth.

1.11. CLASSIFICATION OF SCALES

The scales drawn on the maps or plans, may be classified as under: (*i*) Plain scale (*ii*) Diagonal scale.

1. **Plain Scales.** A plain scale is one on which it is possible to measure only two dimensions, *i.e.*, meters and decimeters; kilometers

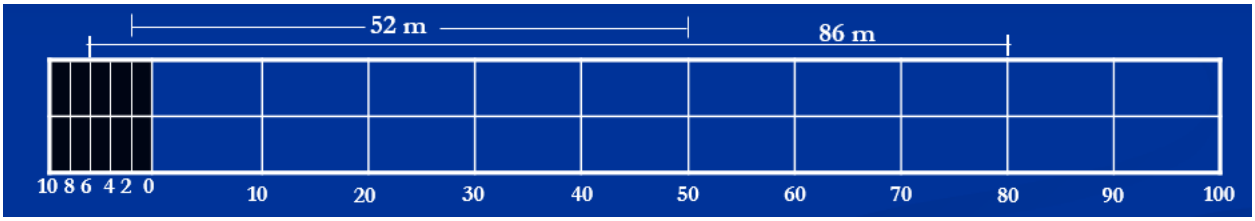
Plain Scales as Recommended by IS: 1491 - 1959

Full Size 1: 1
50 cm to a meter 1: 2
40 cm to a meter 1: 2.5

20 cm to a meter 1: 5
10 cm to a meter 1: 10
5 cm to a meter 1: 20
2 cm to a meter 1: 50
1 cm to a meter 1: 100
5 mm to a meter 1: 200
2 mm to a meter 1: 500
1 mm to a meter 1: 1000
0.5 mm to a meter 1: 2000

Example: - **Construct a linear scale 1 / 1000 to read (2 m) accuracy and measured a distances (52 m) , (86 m) on it ?**

ANS :- scale 1 / 1000 R.F 1cm on a map = 10 m on ground
No. of division = value of main part / scale accuracy = 10 / 2 = 5



2. Diagonal Scales. On a diagonal scale, it is possible to measure three dimensions such as kilometers, hectometers and decameters