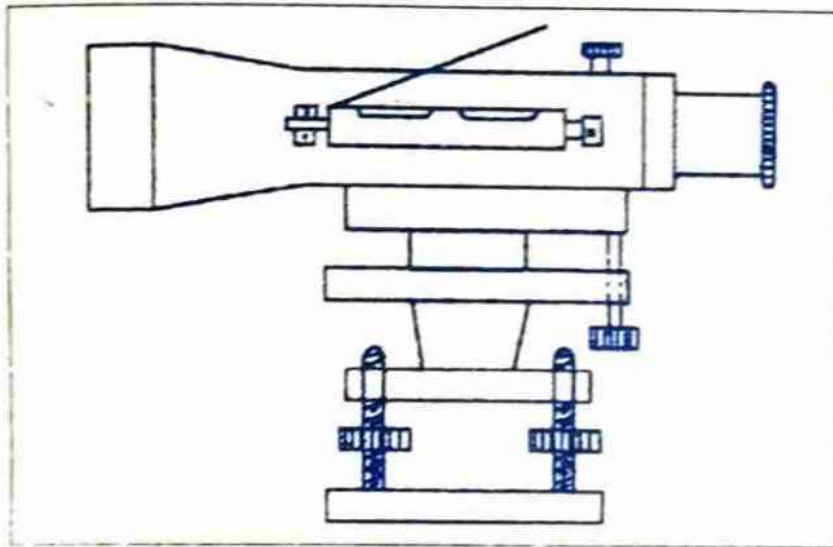


CIVIL ENGINEERING -I

(Summary and Question Bank)



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(Summary and Question Bank)

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By The Same Author
CIVIL ENGINEERING - I
CIVIL ENGINEERING - II
SURVEYING-I
CIVIL ENGINEERING - I
(Summary and Question Bank)

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Preface

This book is in continuation and support of author's book 'CIVIL ENGINEERING-I'. In this book summary of all the chapters have been given, which would be very helpful to the students in brushing up the topics. Thereafter Question Bank for Viva-voce consisting of large typical questions and answers based on principles, construction and use of survey instruments is given for convenience of students.

Hope this book would receive appreciation and encouragement. It is intended to lay the direction and there is always scope for further improvement of contents as well as presentation. Suggestions are very much welcome.

June, 2003

Dr. Ashok Dhariwal

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1.

INTRODUCTION

1. Surveying is the art of making such measurement as will determine the relative positions of points on the surface of the earth in order that the shape and extent of any portion of the earth's surface may be ascertained and delineated on a map or plan. i.e. surveying is the determination of relative positions of points on the surface of the earth, and the production of plans or maps.

2. Levelling is the art of determining and representing the relative heights or elevations of different points on the surface of the earth. It is the process of determining positions of points in a vertical plane.

3. The primary object of a survey is the preparation of a plan or map. The results of surveys when plotted and drawn on paper constitute a plan. i.e. the primary objectives of surveying are the delineation of property boundaries and the collection of the data required for the design and construction of engineering projects.

4. The basic principle of surveying is to work from the whole to the part using various methods to fix points relative to already fixed points.

5. The earth has the shape of an oblate spheroid, but may be taken in practice to be a sphere. Geodetic surveying takes into consideration the curved shape of the earth, while plane surveying ignores it, treating it instead as a plane surface. For large areas and for greater accuracy, geodetic surveying is preferred.

6. Surveys may be classified in a number of ways based on the nature of the field of survey, on the aim of the survey, on the instruments employed, and on the methods used.

2. Planning, field work and office work are the important phases of surveying.

8. Surveying has been practised since ancient times. It was used in ancient Egypt, Greece and Rome. Present-day applications of surveying encompass many fields, especially engineering.

9. In surveying the relative positions of points are located by measurements from at least two points of reference whose positions must be known. Two points selected in the field and the distance between them is measured. The line is then plotted to some scale on the paper.

10. The scale of a map or drawing is the fixed proportion the every distance on the map or drawing bears to the corresponding distance on the ground. Thus, if 1 cm on the map represents 10 m on the ground, the scale of the map is 10 m to 1 cm or ten written simply as 1 cm = 10 m. The scale is also expressed by means of a fraction whose numerator is invariably unity. The fraction is called a Representative Fraction (R.F.). It is, therefore, the ratio of map representative fraction both numerator and denominator must be reduced to the same denomination.

MEASUREMENT OF DISTANCE

2.

1. Measurements of observations are an essential part of any survey. The quantities measured in most surveys are distances and angles. Measurements are never exact, they are bound to contain errors. Measurements may be direct or indirect; the latter are common in surveying.

2. Where approximate results are required, distances may be determined by pacing. The method is mainly used for exploratory or reconnaissance surveys, the preparation of military plans, locating details in small-scale mapping. It may be used for approximately checking more accurate measurements of distance.

3. Passometer is an instrument, which is used for measuring the distance. It is a pocket instrument. The mechanism requires that it should be carried vertically.

4. It is an instrument which is used for measuring the distance. But it registers the distance traversed by the person carrying it. It is fitted with a stud or knob. The mechanism requires that it should be carried vertically.

5. Odometer is an instrument which is used for measuring the distances. It can be attached to the wheel of any vehicle such as a carriage, cart or bicycle and registers the number of revolutions of the wheel.

6. The speedometer of an automobile may be used to measure distance approximately. It gives better results than other methods.

7. Perambulator is an instrument which is used for measuring distances. It resembles a single bicycle wheel provided with forks

and a handle. The distance traversed is automatically registered on the dials.

8. Among the methods of measuring distance, the most accurate and common method is chaining. This method of measuring distance with a chain or tape is called chaining. Wherever great accuracy is required, a steel tape is invariably used.

9. The steel band also called band chain, consists of a ribbon of steel with a brass swivel handle at each end. It is 20 or 30 m long and 16 mm wide.

10. The Gunter's chain is 66 ft long. It is divided into 100 links, each 0.66 ft long. It is very convenient for measuring distance in miles and furlongs. It is used for land survey.

11. The revenue chain is used for measuring fields in cadastral survey. It is 33 ft long and divided into 16 links.

12. The Engineer's chain is 100 ft long. It is divided into 100 links, each 1 ft long. It is used on all engineering surveys. The distance measured with the Engineer's chain is recorded in feet and decimals.

13. The measuring tapes are usually available in the following four different kinds of the materials

- a. Linen or cloth tape; b. Metallic tape;
- c. Steel tape; d. Invar tape;

14. Wooden pegs are used for marking the positions of stations. They are made of hard timber. Pegs are tapered at one end. They are 2.5 cm square and 15 cm long. But in soft ground pegs 40 to 60 cm long and 4 to 5 cm square are suitable.

15. The ranging rods are used for marking the positions of stations for ranging the lines. They are made of well-seasoned straight grained timber of teak, blue pine, deodar. They are circular or

octagonal in cross-section of 3 cm nominal diameter and shod with cross shoe 15 cm long at the lower end.

16. Plasterer's laths are very useful when ranging out long lines. When the forward ranging rod may not be visible due to uneven ground or obstructions such as hedges, walls etc. They are easily visible at a great distance.

17. The line ranger is a small reflecting instrument used for fixing intermediate point on the chain lines. It consists of two right-angled isosceles triangular prisms placed one above the other.

18. Indirect ranging is resorted to when the ends of a line are not intervisible due to high ground or the distance being too great. In such a case, intermediate points can be fixed on the line by the process known as reciprocal ranging.

19. Errors may be due to natural causes, instrument defects, and human factors. In order to deal with them, errors are classified as gross errors or mistakes, systematic errors, and random errors.

20. Error in chaining may be classified as

- a. Compensating errors; and b. Cumulative

These errors may be due to natural causes such as variation in temperature, defects in construction and adjustment of the instrument, personal defects in vision etc.

21. Error in length due to incorrect chain

$$\text{Corrected length} = \text{Measured length} \times \frac{L'}{L}$$

Error in area due to incorrect chain

$$\text{True area} = \text{Measured area} \times \left(\frac{L'}{L}\right)^2$$

Error in volume due to incorrect chain

$$\text{True volume} = \text{Measured volume} \times \left(\frac{L'}{L}\right)^3$$

22. Chaining on the surface of a sloping ground gives the sloping distance. For plotting the surveys, horizontal distances are required. It is, therefore, necessary either to reduce the sloping distances to horizontal equivalents or to measure the horizontal distances between the stations directly.

23. The Clinometer is most commonly used instrument for measuring the angle of slope. It consists of

- A graduated semicircle resembling a protector;
- Two pins for sighting; and
- A light plumb-bob on a long thread suspended from the centre

24. The following mistakes are commonly made by inexperienced chainmen

- Displacement of arrows;
- Failure to observe the position of zero point of the tape;
- Adding or omitting a full chain or tape length;
- Reading from the wrong end of the chain;
- Reading numbers incorrectly;
- Calling numbers wrongly;
- Wrong booking;
- Reading wrong metre-marks.

25. Indirect method by measuring along slope there are three methods to measured distance.

- $D = \Sigma l / \cos \theta$
- $D = 100(\sec \theta - 1)$ links.
- $D = \sqrt{l^2 - h^2}$
- Slope correction = $\frac{h^2}{2l}$
- Slope correction when angles is very small

$$C_h = \frac{\frac{3}{2} \times l \times \theta^2}{10000}$$

26. Precise measurements of distance are made by means of a steel tape 30 m or 50 m in length. Before use it is desirable to ascertain its actual length by comparing it with the standard tape of known length.

27. There are five types of tape correction to be applied

- Correction for absolute length $C = \frac{l \times c}{l}$
- Correction for temperature $C_t = \alpha \times (T_m - T_0) L$
- Correction for pull (or tension) $C_p = \frac{(P - P_0) \times L}{AE}$
- (i) Correction for sag $C_s = \frac{l(w/l)^2}{24P^2}$
(ii) Normal tension = $P_n = \frac{0.204W \sqrt{AE}}{\sqrt{P_n - P_0}}$
- Correction for slope or vertical alignment $C_g = \frac{h^2}{2l}$

CHAIN SURVEYING

1. Chain surveying derives its name from the fact that the principal equipment used is the chain, with which only linear measurements can be made. The chain is 20 m or more often, 30 m long. A steel band can be much longer and more accurate.
2. The line ranger, cross-staff, optical square, and prism square are among the devices used to set out perpendicular directions. The offset rod is used to measure short offsets.
3. The principles of geometry are used to solve many field problems, and to overcome obstacles in chaining.
4. Chaining along a sloping ground may be done directly by stepping or indirectly by correcting the inclined length to obtain the horizontal distance. The angle of slope or difference in level between the ends is required for this correction, known as the hypotenusal allowance.
5. Errors in chaining can be cumulative or compensating. They must be accounted for to set correct length. The nominal length of a measuring unit is standardised at a certain temperature and pull. Corrections will be necessary if the field conditions differ from those of standardization. A correction for sag is required when the chain or tape is supported above the ground, since it was standardised by keeping it on the flat.
6. Triangulation and traversing are the two main approaches to land surveying. Check lines and tie line are used as checks in the field work.
7. The limiting length of an offset is determined by the accuracy desired and the scale proposed to be used.

8. Well-conditioned triangles are used to improve accuracy in chain surveying.
9. Conventional signs are used in the plotting of a chain survey.
10. In chain surveying the sides of the various triangles are measured directly in the field and no angular measurements are taken. It is the simplest kind of surveying.
11. If a point is located by the intersection of two arcs, its displacement due to errors in the radii is the minimum, if the arcs intersect at 90° . The three sides of a triangle being equally liable to error, each of the three angles of a triangle should be nearly 60° , i.e., the triangle should be equilateral. An equilateral triangle can, therefore, be more accurately plotted than an obtuse-angled triangle. Hence the best-shaped triangle is equilateral and it is desirable to approximate any triangle to this form in order that the distortion due to errors in measurement and plotting is a minimum.
13. Main stations are the ends of the lines which command the boundaries of the survey and the lines joining the main stations are called the main survey or chain lines.
14. Tie stations are the points selected on the main survey lines where it is necessary to run auxiliary lines to locate the interior detail such as fences, buildings, nalla, railway lines, etc., when they are distant from the main lines. They are conveniently fixed while the chaining of the main line is in progress. The lines joining the subsidiary or tie stations are called the subsidiary or tie lines.
15. The longest of the chain lines used in making a survey is generally regarded as the base line.
16. The line which is run in the field to check the accuracy of the fieldwork is called the check line.
17. A tie line is a line joining some fixed points termed as tie stations on the main survey lines.

18. In chain surveying, the base line is the most important line. It fixes the directions of all other chain lines. The following points are kept in view while selecting and measuring a base line.

19. Offsets are lateral measurements made to locate the positions of the details such as boundaries, buildings, fences, roads, railways etc., with respect to the survey lines.
20. Oblique offsets are taken to locate details at a great distance from the chain line or when the details are important such as the corners of a building or boundary pillars of adjoining properties. They are also taken to check the accuracy of perpendicular offsets.
21. The field measurements, sketches and relevant notes are recorded for plotting the data and also for future reference in a notebook known as a field-book.
22. In booking the field notes, we start at the bottom of the page and work upwards as if we are writing them on the actual chain line.
23. A chain or tape may be used for setting out a right angle. There are two methods, of which the one is based on the fact that a triangle whose sides are in the proportion of 3, 4 and 5 is right-angled.
24. Various obstacles or obstructions such as woods, hills, ponds, rivers, buildings etc. are continually met with in chaining. It is however, essential that chaining should be continued in a straight line. Special methods are therefore, employed in measuring distances across the obstructions.

4.

COMPASS SURVEYING

1. A compass is an instrument devised to determine directions, specifically bearings or angles made by survey lines with respect to the magnetic meridian of the earth. Surveyor's, prismatic, trough and tubular compasses are the common types.
2. The dip of a magnetic needle is its inclination in the vertical plane. The north end of the needle dips in the northern hemisphere and the south end in the southern hemisphere. The dip is compensated in a compass by means of movable rider or weight on the needle. The horizontal angle between the magnetic meridian and the true or geographic meridian at any place is the magnetic declination variation. A needle pointing to the east of the true meridian gives an east declination, and a needle pointing to the west, gives a west declination.
3. The true bearing of a line may be obtained from its measured magnetic bearing by adding or subtracting the declination, according as it is an east or a west declination.
4. The magnetic declination varies from place to place, and also with time at any particular place. The variations can be secular, diurnal and annual. Secular variations are the most significant; they range from 10° W to 24° E. Irregular variations are caused by magnetic storms. The isogonic charts for a region are prepared by determining the declination at several places by using astronomical observations, and comparing the true bearing thus obtained with the measured magnetic bearings.
5. The deviation of a magnetic needle caused by local sources such as steel or iron objects, electric lines and iron ore deposits is called a local attraction. It can be detected by comparing the forward and back bearings of a line, which must differ by 180° . It can be

corrected in a traverse by obtaining included angles, which are free from errors inspite of local attraction, and carrying the bearings forward, starting from a line that is free from local attraction.

6. A compass is commonly used to run a closed or open traverse, picking up detail in the vicinity either by offsets or by intersection of bearing lines. The fieldwork involved is the measurement of bearings of all lines with a compass and the lengths of sides by chain or tape.

7. Included angles may be obtained from the bearings of adjacent lines by combining them appropriately. Angle disclosure in a closed traverse must be adjusted by correcting the angles at all stations other than those free from local attraction.

8. If all the included angles of a closed traverse and the bearing of one of the lines is known, the bearings of all the other lines can be computed by carrying forward the bearings. The calculations can be done in the office or directly in the field.

9. A compass traverse can be plotted using either parallel meridians or rectangular coordinates. Commonly used rectangular coordinates are: the latitude (projection parallel to the north-south direction), and the departure (projection parallel to the east-west direction). The rectangular coordinates method is more accurate, but is more often used to plot theodolite traverses.

10. The linear closing error, that may occur when plotting a closed compass traverse is adjusted analytically or graphically by Bowditch's method. This is based on the principle (called the Bowditch, or compass rule) that the linear error is proportional to the length of the side in relation to the perimeter of the traverse.

11. A survey in which series of connected straight lines whose lengths and directions are measured with tape and compass is called a traverse. End points are known as traverse station and straight lines between two consecutive stations, are called traverse legs.

12. A traverse is said to be closed when a complete circuit is made, i.e., when it returns to the starting point forming a closed polygon.

13. A traverse is said to be open when it does not form a closed polygon.

14. The compass consists essentially of a magnetic needle, a graduated circle, and a line of sight.

15. The surveyor's compass was formerly much used in land surveying, but now it is obsolete. It is similar in construction to the prismatic compass, with a few modifications.

16. The bearing of a line is the horizontal angle which the line makes with some reference direction or meridian. The reference direction employed in surveying may be

1. A true meridian, 2. A magnetic meridian and
3. An arbitrary or assumed meridian;

17. It represents true north-south direction at the place. The line of intersection of the earth surface by a plane containing north pole, south pole and the observer's position is called true meridian or geographical meridian. Geographical meridian at different places are not parallel to each other. These converge to the poles in northern and southern hemispheres.

18. The true meridians through the various stations are not parallel, but converge to the poles. For ordinary small surveys, they are assumed to be parallel to each other. The horizontal angle between the true meridian and a line is called a true bearing of the line. It is also known as an azimuth.

19. The direction indicated by a freely suspended and properly balanced magnetic needle, unaffected by local attractive forces is called the magnetic meridian or the magnetic north and south line.

20. The convenient direction which is assumed as a meridian for measuring bearings of survey lines, is known as arbitrary meridian.

21. The whole circle bearing of a line is always measured clockwise from the north point of the reference meridian towards the line right round the circle.

22. In quadrantal bearing system the bearing of lines are measured eastward or westward from North and South whichever is nearer. In this system, both north and south directions are used as reference meridians and bearings are reckoned either clockwise or anticlockwise, depending upon the position of the line.

23. When the whole circle bearing of a line exceeds 90° , it must be reduced to the corresponding angle less than 90° which has the same numerical values of the trigonometrical functions. This angle is known as the reduced bearing (R.B.).

24. Every line has two bearings one observed at each end of the line. The bearing of a line in the direction the progress of survey is called the fore or forward bearing (F.B.), while its bearing in the opposite direction is known as the back or reverse bearing (B.B.).

25. Bearings of lines may be either observed or calculated. Observed bearings are those which are directly obtained by field observations, while those obtained by computation are called the calculated bearings.

26. The magnetic needle is liable to be disturbed from its normal position if it is under the influence of external attractive forces.

27. The closing error also termed as the error of closure is the actual distance by which the traverse fails to close. If the closing error is large, it indicates that an error has been made in chaining and the lines require to be remeasured.

28. If the needle is perfectly balanced before magnetization, it will not remain so after it is magnetized on account of the magnetic influence of the earth. But it will be inclined downward towards the pole. The inclination of the needle with the horizontal is known as the dip of the needle.

29. The magnetic meridian at a place does not coincide with the true meridian at that place except at few places. The horizontal angle which the magnetic meridian makes with true or geographical meridian is known as the magnetic declination or the declination of the needle.

30. Isogonic charts are published by the Survey of India. The lines passing through points at which the declination is the same at a given time, are called isogonic lines. The lines joining points of zero declination are called agonic lines.

31. True bearing of a line = Magnetic bearing of the line $\pm$ Declination. Use plus sign, when the declination is east and minus sign when it is west.

32. Magnetic bearing of a line = True bearing of the line $\pm$ Magnetic declination. Use plus sign, when the declination is west and minus sign when it is east.

5. LEVELLING

1. The art of determining relative heights or elevations of points on the surface of the earth, is called levelling. This branch of surveying deals with measurements in vertical planes.
2. A level surface is any surface parallel to the mean spheroidal surface of the earth. Every point on this surface is equidistant from the centre of the earth.
3. A level line is a line lying in a level surface. It is, normal to the plumb line at all points.
4. A horizontal plane through a point is plane tangential to the level surface at the point. It is perpendicular to the plumb line at the tangent point.
5. A horizontal line is any line lying in the horizontal plane. It is a straight line tangential to a level line.
6. A vertical line at any point is a line normal to the level surface through that point, e.g. a plumb line.
7. The plane which contains the vertical line at a place, is, called a vertical plane.
8. An angle between two intersecting lines in a vertical plane is called vertical angle. One of the two lines is commonly taken as horizontal in surveying.
9. A datum surface or line is any arbitrarily assumed level surface or line from which vertical distances are measured.

10. The elevation of a point is its vertical distance above or below the datum. The elevation of a point is plus or minus according as the point is above or below the datum.
11. The difference in elevation between two points is the vertical distance between the level surfaces passing through the two points.
12. A relatively permanent and fixed reference point of known elevation above the assumed datum, is called a bench mark.
13. The line of collimation is the line joining the intersection of the cross-hairs to the optical centre of the object glass and its continuation. It is also called the line of sight.
14. An axis of the telescope is a line joining the optical centre of the object glass to the centre of the eye-piece.
15. An axis of the level tube or bubble tube is an imaginary line tangential to the longitudinal curve of the tube at its middle point. It is also known as the bubble line. It is horizontal when the bubble is centered.
16. The vertical axis is the centre line of the axis of rotation.
17. The point in a lens through which rays pass without any lateral displacement, is called optical centre. It is so situated in the lens that its distances from the curved surfaces, are directly proportional to their radii.
18. A station is a point whose elevation is to be determined or a point which is to be established at a given elevation. It may be noted that it is a point where the staff is held.
19. The height of instrument of the plane of collimation, when the instrument is correctly levelled is known as height of instrument. It is also called the "height of plane of collimation"

20. The first sight taken on a levelling staff held at point of known elevation, is called backsight.

21. The reading taken on a levelling staff held at a point of unknown elevation to ascertain the amount by which the point is above or below the line of sight, is called a foresight.

22. This point indicates shifting of the level. At this point both the foresight and backsight, are taken during the operation of levelling. The change point is always selected on a relatively permanent point such as boundary stone, rail, rock etc., so that it could act as a check in case of any errors.

23. The reading(s) taken on a levelling staff held at point(s) between two turning points, to determine the elevation of the point(s), is known as intermediate sight.

24. The setting of the eye-piece and the objective at the proper distance apart for the clear vision of the object sighted is called focussing.

25. When the image of an object formed by the objective does not lie in the plane of the cross-hairs, any movement of the eye causes an apparent movement of the image with respect to cross-hairs. This shift of the image, is called parallax.

26. It is the operation of levelling to determine the elevations of points some distance apart or to establish bench marks. The process is the same as that described in continuous or compound levelling. It is also known as "taking flying levels".

27. It is operation of running levels for the purpose of checking a series of levels, which have been previously fixed. At the end of each day's work, a line of levels is run, returning to the starting point of that day with a view to check the work done on that day.

28. It is the operation in which the object is to determine the elevations of points at known distances apart along a given line

and thus to obtain the accurate outline of the surface of the ground. It is also called the longitudinal levelling or sectioning.

29. It is the operation of levelling which is carried out to provide levels on either side of the main line at right angles, in order to determine the vertical section of the earth surface on the ground.

30. It is operation of levelling in which difference in elevations between two points is accurately determined by two sets of reciprocal observations, is called reciprocal levelling. Reciprocal levelling is employed when it is not possible to set up the level between two points due to an intervening obstruction such as large water bodies.

31. It is the method of levelling in which the altitudes of points are determined by means of barometer, which measures atmospheric pressure.

32. It is the method of levelling in which the heights of mountains are found by observing the temperature at which water boils.

33. It is the process of levelling in which the elevations of points are computed from the vertical angles and horizontal distances measured in the field.

34. Precise levelling is mainly employed for establishing a network of bench marks throughout the country by the state agency such as the Survey of India Department.

35. The horizontal line is not a level line, i.e., a line of equal altitude due to the curvature of the earth. The level line falls away from the horizontal line and the vertical distance between the horizontal line and the level line represents the effect of the curvature of the earth.

36. The effect of refraction is, therefore, opposite to that of curvature and the points appear higher than what they really are.

37. The combined effect of curvature and refraction is to increase the staff readings, the combined correction is subtractive.

38. The precision of levelling can be judged from the error of closure. If the absolute reduced levels of starting and closing points are unknown it is the usual practice to carry out levelling twice, firstly in the forward direction and secondly in the backward direction.

39. The capability of a level tube to exhibit small deviation from the horizontal is termed as the sensitiveness or the sensitivity of the level tube.

40. The instruments are properly adjusted by the manufacturer; their fundamental lines get disturbed due to mishandling in the field. The main object of the permanent adjustments is to establish the fixed relationships between the fundamental lines of a level.

41. The atmospheric pressure varies inversely with elevation. This fact is used in the barometric levelling.

42. Levelling means the determination of differences in elevation between points on the earth's surface, or the elevations of points with reference to a chosen datum. A level surface is parallel to the mean surface of the earth, and perpendicular to the plumb line at all points, the surface of still water is an example. For small surveys, the level surface is treated as a plane. A plane normal to the plumb line, or tangential to the earth's surface at a point, is the horizontal plane at a point.

43. The curvature of the earth makes objects look lower than they really are. The earth's atmospheric refraction makes objects look higher than they really are. Their combined effect is to make objects look lower than they really are. In ordinary levelling, curvature and refraction are insignificant.

44. The levelling instrument provides a horizontal line of sight. It consists of a telescope with an objective and an eyepiece, and a

level tube (or bubble tube) mounted on a levelling head. The level tube is the most common type in use. The sensitivity of the dumpy level is the angular value of one division. The sensitivity of the bubble tube is the radius of the arc to which the inner surface of the tube is ground. A levelling staff is an important adjunct of levelling. It is a graduated staff that is read through the levels telescope. Besides the dumpy level, the wyes and tilting levels are also used. Reversible and automatic levels combine the features of the dumpy and wyes levels.

45. Setting up, levelling, and elimination of eyepiece and objective parallax are the temporary adjustments of a level that must be carried out at every set-up.

46. The important types of levelling are fly levelling, longitudinal sectioning, cross sectioning, and reciprocal levelling. Precise levelling and trigonometric levelling are for accurate work, while barometric and hypsometric levelling is very rough, used only for reconnaissance surveys.

47. A benchmark is a reference point of known or assumed elevation. It may be permanent, temporary or a GTS benchmark with reference to the mean sea level. A levelling change point is a staff station on which a foresight and a backsight are taken from different consecutive set-ups. Change points help the surveyor maintain continuity of levelling. All levelling observations are recorded in a level field-book.

48. There are two ways to reduce levels: The height of collimation, and the rise and fall systems. The former is simple, but the latter provides a better check on arithmetical work. Even missing entries can sometimes be reconstructed.

49. Longitudinal sections and cross-sections are very popular in route surveys for highways and railways. They are useful in computing the earthwork involved.

50. Reciprocal levelling is the technique used to cross a deep gorge or wide stream, while maintaining continuity of levelling.

51. Setting out levels for a grade contour or contour gradient is common in construction surveys.

52. Reading through the objective, taking inverted staff readings, and taping to cross a wall are some of the techniques used to overcome some practical difficulties in levelling.

53. A contour is an imaginary line joining all points of equal elevation. Producing a contour plan of an area by surveying is called contouring. The difference in elevation between successive contours is the contour interval. The characteristics of contours make it easy to interpret the topographic features of a contour map. Both direct and indirect methods are employed for contouring. Among the more important indirect methods are block levels and the radial method. Contours can be interpolated between points of known levels by estimation, calculation, or graphical methods. Contour maps are mainly used to draw sections, trace contour gradients, compute earthwork, and determine the capacity of a reservoir.

54. The important permanent adjustments of a dumpy level are to the bubble tube and the collimation, the latter being the more important. The principle of reversal is employed.

55. The two-peg test and its variations are commonly used to effect the collimation adjustment. They can be used to determine the collimation error, including that due to curvature and refraction.

56. Instrumental errors, errors of manipulation, and errors due to natural causes are the sources of error in levelling. Simple precautions enable one to get good results.

6.

MINOR INSTRUMENTS

When speed, not accuracy, is the criterion, as in reconnaissance and preliminary surveys, relatively simple, more portable 'minor' instruments are used. They are the box sextant, hand level, Abney level, India pattern clinometer, Ceylon ghat tracer for field level, India pattern pantagraph, eidograph and planimeter for measurements, and the pantagraph, eidograph and planimeter for office work.

1. The box sextant is the most popular type of sextants. It is based on the principle that the deviation of a ray of light from two successive reflecting mirrors is twice the angle between them. A fixed horizon glass, silvered on the top half, a rotating index glass which is fully silvered, graduated arc, and a milled-head screw are the primary components. The line of sight may be a simple pin-hole and cross-hair system, or telescopic. Box sextants are used to measure or set out angles.

2. A hand level is a small level held in the hand. It consists of a sighting tube and a level tube. The line of sight is an eye-hole horizontal-hair system. It is used like other levels to read a staff.

3. The Abney level is so designed that it can be used both as a hand level and as a clinometer to measure gradients. A sighting tube, bubble tube and graduated arc are the important parts.

4. The India-pattern or tangent clinometer enables the surveyor to read the tangents of angles of slope. An eye vane and an object vane provide the line of sight. On the object vane are graduations indicating tangent values above and below zero. This device is commonly used in conjunction with a plane table.

5. The Ceylon ghat tracer is used to set out grade contours or measure gradients, especially for the preliminary surveys of

mountain roads. A hollow brass sighting tube, and a movable weight which tilts the lines of sight, and slides relative to a calibrated scale, are the main parts.

7. The pantagraph is used to enlarge or reduce plotted plans. But it has so many hinges and supports that it is relatively unstable and tends to give inaccurate results, especially during enlargement.

8. The eidograph is an improved pantagraph with fewer hinges and supports. It gives better results in the reduction and enlargement of plans, especially the latter.

9. A planimeter is a mechanical integrator used to measure areas within irregular boundaries. A tracing arm, the anchor arm, with anchor weight, and two short arms hinged to the longer arms constitute the main components. Ansler's polar planimeter is the most commonly used type. The area of the zero circle should be added only when the anchor point is kept inside the figure.

10. Hand level is a simple and compact instrument for making observations.

11. Hand level is generally used for rough work such as reconnaissance and preliminary surveys, locating contours and taking short cross sections.

12. Clinometers are used in vertical angle measurements, finding out slope of the ground and locating points on a given grade.

13. Abney's level is one of types of clinometers which is used for rapid work of low precision.

14. Ceylon Ghat Tracer is an instrument used for locating a number of points on a given contour gradient during preliminary route surveys of a hill road and also for measuring the angles of slope.

The box Sextant is a reflecting type of instrument which is capable of measuring angles upto 120° with an accuracy upto one minute.

The principle of Sextant is when a ray of light is reflected successively from two planes mirrors, the angle between the first incident ray and the last reflected ray is twice the angles between the planes of the two mirrors.

17. Nautical Sextant and Sounding Sextant are the types of sextants other than box sextant.

18. The optical principle of a box sextant assumes that the position of the observer's eye while making observations remains at the point of intersection of the direct ray and the incident ray. In case the eye is kept at some other point an error is introduced in the observed angles. This error is known as the parallax of the box sextant.

19. When the two mirrors are parallel, the vernier must read zero. In case the vernier reads other than zero, there is said to be an index error. The index error is added to or subtracted from all observed angles according as the vernier index appears on the left, or right of the zero of the graduated arc.

20. A subtense bar is a horizontal staff with targets fixed at a known distance apart.

21. Range finders establish a right-angled triangle which has its base at the instrument and its apex at the observed target point.

22. A pantograph is an instrument used for enlarging, reducing or reproducing the plans. The instrument works on the principle of similar triangles.

VIVA-VOCE QUESTION BANK

In this Question Bank, the questions are based on the instruments, the students have studied during the course. The student is expected to know the principles, the constructional details and use of survey instruments. It is therefore essential to give emphasis on the development of skills in using various surveying instruments and develop skill of recording and plotting surveyed data.

Q. What is fundamental difference between surveying and levelling?

Ans. In surveying, the measurements are taken in horizontal plane, but in levelling they are taken in vertical plane.

Q. Define surveying and levelling.

Ans. Surveying: - surveying means taking either horizontal or vertical measurements to determine the relative positions on the surface of the earth.

The main object of surveying is to prepare drawing, i.e., map to a suitable scale.

Levelling: - It is a branch of surveying to determine the relative heights or elevations of different points on the surface of the earth. It deals with the measurements in vertical plane.

Q. What is the fundamental difference between plane surveying and geodetic surveying?

Ans. In plane surveying the curvature of the earth is not considered. But in geodetic surveying, curvature of the earth is considered.

Q. Distinguish between plane surveying and geodetic surveying.

Ans. The following are the points of distinction

1. In plane surveying, the curvature of the earth is not taken into account. But in geodetic surveying the curvature is taken into account.
2. In plane surveying, short distances and small areas are covered. But geodetic surveying covers long distances and large areas.
3. In plane surveying, the area covered is less than 260 km^2 or 100 sq. miles. but in geodetic surveying the area covered is more than 260 km^2 or 100 sq miles.
4. In plane surveying, the lines are considered straight. But in geodetic, the lines are assumed to be curved.
5. In plane surveying, the angles and triangles are treated as plan. But in geodetic surveying, the angle and the triangle are assumed to be spherical.

Q. While considering the curvature of the earth, what is the difference in length between an arc and the corresponding chord.

Ans. It is found that the difference is
10 cm in length of 18.2 km.
30 cm in length of 54.5 km.
50 cm in length of 91 km.

Q. What is the difference between the sum of angles of a plane triangle and that of a spherical triangle?

Ans. The difference of the sum of the angles is only one second for an area of 195.5 km^2 .

Q. What is the advantage of triangulation?

Ans. The advantage is that the triangles formed during the process can be easily plotted by knowing only the lengths of their sides; no angular measurements are required.

Q. In chain surveying, how can the direction of the adjacent sides be fixed?

Ans. The direction can be fixed forming chain angles with the help of tie stations and tie lines.

Q. What are the different types of survey?

Ans.

Topographical survey: This is done to determine the locations of the towns, villages, roads, railways, rivers, etc. and to know the nature of the ground surface.

Cadastral survey: Cadastral survey is undertaken to mark the boundaries of fields and other properties.

Geological survey: Geological survey is conducted in order to identify the different strata of the crust of the earth and expose concealed wealth like oil, natural gas, etc.

Geographical survey: This is done to locate hills, valleys, forests, and other geographical features of a country.

Archeological survey: This is done to unearth ancient relics.

Mine survey: The aim of such survey is to identify areas exploring mineral wealth like coal, iron ore, mica, gold, etc.

Military survey: This is done to set up road and railway communication for the defense of the country.

City survey: City survey is undertaken to show the different plots, streets, sewer, sewer lines, water lines, etc in a city.

Contour map: Such a map is prepared in order to illustrate the nature of the ground surface in particular area.

Engineering Survey: This is done for the projects involving roads, railways, irrigation canals etc.

Hydrographic survey: This is undertaken in order to obtain rainfall records in catchment area and measure the discharge of a river (river gauging).

Marine survey: This is done for fixing the positions of docks, harbors, and lighthouses.

Q. What are the different types of scales?

Ans

Plain scale: Using this scale two consecutive units or $1/10^{\text{th}}$ of a unit can be measured.

Diagonal scale: With this scale three consecutive units or $1/100^{\text{th}}$ of a unit can be measured.

Comparative scale: Using such scale two different systems of units can be measured, e.g. cm v inch, metre v. feet, time v. distance etc.

Vernier scale: The vernier scale is meant for measuring fractional parts of the smallest division of the main scale.

Direct vernier: Here, the vernier division is longer than the primary division.

Retrograde vernier: In this scale, vernier division is longer than the primary division.

Double vernier: Here, vernier graduations are marked in both directions.

Q. What would you mean by the terms "small" and "large" in the context of a scale?

Ans In a small scale, 1 cm represents a large distance e.g. 1 cm = 1 km. In a large scale, 1 cm represents a small distance e.g. 1 cm = 1 m.

Q. What do you mean by the terms 'topographical map' and cadastral map?

Ans. A map which shows the natural features of a country such as rivers, hills, roads, railways, villages, towns etc., is known as a topographical map and one which shows the boundaries of estates, fields, houses etc. is known as a cadastral map.

Q. State the main principle of surveying?

Ans. The fundamental principle of surveying is to work from the whole to the part.

Q. State the uses of surveys.

Ans. Uses of surveys.

1. Preparing maps of states and countries.
2. Measurement of land and establishment of boundaries.
3. In engineering projects such as highways, railways, irrigation for preparation of plans and sections.

Q. Enlist the types of chains.

Ans. There are five kinds of chains used for surveying;

1. Engineer's chain
2. Gunter's chain
3. Revenue chain
4. Metric chain

5. Steel band chain

Q. Give the permissible error for 20 m chain and 30 m chain.

- Ans.** 1. For 20 m chain error shall not be more than ± 5 mm.
2. For 30 m chain error shall not be more than ± 8 mm.

Q. How will you calculate the correct length of line between two points?

Ans. If the distance is measured by incorrect length, then the correct distance is calculated by the following formula:

The correct length of line = $\frac{L_1}{L} \times$ Measured length

Where L_1 = incorrect length of chain

L = correct length of chain

$L_1 > L$ if chain is too long and $L_1 < L$ if chain is too short.

Q. What is the least count of metallic tape and steel tape

Ans. Least count of metallic tape is 10 mm.
Least count of steel tape is 5 mm.

Q. What is a ranging?

Ans. The method of establishing intermediate points on a straight line between the two fixed points is known as ranging. It is done before chaining is started. It may be done by the eye or by using some instruments such as line ranger of theodolite.

Ranging may be (i) Direct ranging, or (ii) Indirect ranging

Q. When is direct ranging adopted?

Ans. Direct ranging is adopted when both the ends of survey lines are intervisible.

Q. When is indirect ranging adopted?

Ans. Indirect ranging is adopted when the end of survey lines are not intervisible due to high ground or hill intervening. It is also adopted when the ends of survey lines are not clearly visible due to long distance between them.

Q. Define the chain triangulation.

Ans. It is the system of surveying in which the sides of various triangles are measured directly in the field and no angular measurements are taken.

Q. State the purpose of chain surveying.

Ans. Chain surveying is adopted for the following purposes:

1. To determine the area.
2. To locate the exact boundaries of land.
3. To secure data for making a plan.

Q. Explain the suitability of chain triangulation.

Ans. The chain triangulation is most suitable under the following conditions:

1. When the ground is fairly level and open with simple details.
2. When plans are required on a large scale such as those of estates, fields etc.
3. The area is small in extent.

Q. Explain when chain triangulation is unsuitable.

Ans. Chain triangulation is unsuitable for large areas crowded with many details or a wooden country.

Q. Define survey station.

Ans. A survey station is an important point on the ground at the beginning and end of a chain line. There are two kinds of survey stations:

1. Main stations, and
2. Subsidiary stations or tie stations.

Q. State the precautions to be taken while selecting base line.

Ans. Precautions to be taken while selecting base line are:

1. It should be laid on a level ground as possible.
2. It should run nearly through the centre of the area.
3. It should be correctly measured horizontally twice.

Q. State the necessity of drawing location sketch in the field book.

Ans. Location sketch is very useful in locating the same station after lapse of some time, especially when the peg is displaced or lost.

Q. State any two instruments used for setting perpendicular offset.

Ans. Instruments used for setting perpendicular offset:

1. Open cross-staff, 2. Optical Square.

Q. State the types of cross-staff.

Ans. There are three types of cross-staff:

1. Open cross-staff.
2. French cross-staff.
3. Adjustable cross-staff.

Open cross-staff is used for setting out perpendicular offset while French cross-staff is used for setting out perpendicular offset and offset at an angle of 45° . Adjustable cross-staff is used for setting out angles of any magnitude.

Q. State the uses of Optical Square.

Ans. Uses of Optical Square:

1. To find the foot of the perpendicular to the chain line from a given point.
2. To set out perpendicular to a chain line (AB) at a given point (D) on it. The observer stands on a line holding the instrument over the point D and observes the ranging rod at a B through the unsilvered portion of the horizon glass.

Q. Why is plotting of fieldwork necessary?

Ans. Plotting of fieldwork is necessary for:

1. Preparation of plans and section.
2. Calculating the area of the plot.

Q. State chain and compass traverse.

Ans. A traverse study is one in which frame work consists of a series of connected lines, the length and dimensions of which are measured with a chain or a tape, and with an angular instrument respectively.

Q. State the instruments commonly used for measuring distances?

Ans. Instruments used: Chain, Tape, Ranging rod, Offset rod, Arrows, Pegs, and Plumb bob.

Q. State the types of chains used in engineering?

Ans. Now a days metric chains having length 20 m, 30 m are used.

Q. In chaining operation, who is the leader and who the follower?

Ans. The chain man at the forward end of the chain who drags the chain is known as the leader. The one of the rear end of the chain is known as the follower.

Q. Define the following terms:

1. Chaining
2. Chain man
3. Leader
4. Follower

Ans.

1. Chaining: The method of measuring the distance with chain or tape is called chaining.
2. Chain man: For measuring the length of line two men are required. They are called chain men.
3. Leader: The chain man at forward end of the chain is called the leader.
4. Follower: The chain man at zero or rear end of the chain is called follower.

Q. How many ranging rods are required to range a line?

Ans. At least three ranging rods are required for direct ranging and at least four for indirect ranging.

Q. Give the length of one link and number of links in 20 m chain and 30 m chain?

Ans. Length of one link is 20cm. Number of links in 20 m chain is 100. Number of links in 30 m chain is 150.

Q. Name the joint between the first link of the chain and the handle. State its purpose ?

Ans. The joint between the first or last link and the handle is 'Swivel' joint. It affords turning round the chain without twisting.

Q. State the purpose of tallies or tags in chain ?

Ans. Tallies or tags are provided to facilitate the measurement of distance i.e. 5m, 10m tallies in case of 20m chain and 5m, 10m, 15m tallies in case of 30m chain.

Q. State the method of adjusting the chain

When the chain is found too long.

When the chain is found too short.

Ans. a) When the chain is found too long.

1. By closing up the joints of the opened rings.

2. By hammering back to the original shape of flattened oval ring.

3. By replacing some of the worn rings.

4. By adjusting links at the handles.

b) When the chain is found too short.

By straightening the bent up rings.

By flattening some of the rings.

By replacing some of the rings by larger ones.

By the adjustable rings at the handles.

By adding new rings as required.

Q. State the type of tapes:

Ans. Cloth or linen tape, Metallic tape, Steel tape, Fibre glass tape, and Invar tape.

Q. Why the name is metallic tape ?

Ans. It is known as metallic tape because metallic wires are woven in the linen, which prevents the tape from stretching or shrinkage.

Q. State the material used in invar tape. Give the use of it.

Ans. Invar tape is made up of an alloy of steel 64% and nickel 36%. It has a very low coefficient of thermal expansion. It is very costly and delicate and should only be used in very accurate measurements.

Q. State the use of ranging rods.

Ans. Ranging rods are used for:

Ranging survey lines and

Marking positions of stations.

Q. Give reason for:

Painting ranging rods in alternate colours.

Providing iron shoe at the bottom.

Ans. 1. Ranging rods are painted in alternate colour so that they can be seen at a distance.

2. An iron shoe is provided at the bottom of ranging rod to facilitate fixing it into the ground.

Q. Write the necessary action to the following signals:

1. Rapid sweeps with right hand.

2. Slow sweeps with left hand.

3. Left arm extended.

4. Both hands above head and brought down.

Ans.

1. Rapid sweeps with right hand: Move considerably to the right.

2. Slow sweeps with left hand: Move slowly to the left.

3. Left arm extended: Continue to move to the left.

4. Both hands above the head and brought down: Correct.

Q. State the use of:

Offset rod, 2. Arrows, 3. Pegs, 4. Plumb bob

Ans. 1. Offset rod is used for measuring the length of offsets roughly. It is usually 3m long and divided into parts of 0.2m lengths.

2. Arrows are used to mark the end of each chain during chaining.

3. Pegs are used for marking the positions of stations on the ground.

4. Plumb bob is used to transfer the points to the ground while chaining on sloping ground as in method of stepping. It is also used for accurate centering of theodolite, plane table etc.

Q. State the principle of chain surveying.

Ans. The principle of chain surveying is triangulation.

Q. What do you mean by triangulation ?

Ans. The method of dividing an area into a number of triangles is known as triangulation.

Q. Enlist the instruments for setting out right angles in chain survey.

Ans. 1. Chain or tape, 2. Cross staff, and 3. Optical square

Q. What is reconnaissance survey ?

Ans. The preliminary inspection of the area to be surveyed is known as reconnaissance survey.

Q. State the principle and use of optical square.

Ans. Principle of Optical Square: In case of reflecting instrument, the angle between the first incident ray and the last reflected ray is twice the angle between the two mirrors.

Use of Optical Square: It is used for setting out perpendicular to the chain line or finding the foot of perpendicular on a chain line.

Q. Give reason for providing angle between two mirrors as 45° in the construction of optical square.

Ans. The optical square is used for setting out 90° angles. According to the principle of optical square, the angle between the first incident ray and last reflected ray is 90° .

Since angle between two mirrors is 45° , we get $2 \times 45^\circ = 90^\circ$.

Q. State the advantages of Prism square over Optical square.

Ans. 1. It is more accurate than optical square.

2. Prism Square needs no adjustments, since the angle between the reflecting surfaces is fixed at 45° .

Q. What is the use of a reference sketch ?

Ans. If the station peg is removed by someone, the station can be located accurately with the help of measurements shown in the reference sketch.

Q. How will you set up a perpendicular with the help of only chain and a tape ?

Ans. By forming a triangle in the ratio of 3:4:5 using a chain and a tape.

Q. What is pacing ?

Ans. Pacing involves measurement of distance by counting the number of paces or steps. The walking step of a man is considered to be equal to 80 cm or 2.5 ft.

Q. What is test gauge ?

Ans. It is standard length fixed by pegs on a level platform to standardize a chain.

Q. What is invar tape ?

Ans. It is a tape made of an alloy of 64% steel and 36% nickel, and used for high-precision work.

Q. What are the different types of minor instruments? Mention their uses.

Ans

Cross staff---for taking perpendicular offsets

Optical square---for taking perpendicular offsets.

Clinometer---for measuring angles of slopes.

Box Sextant---for measuring any horizontal angle.

Abney level---for measuring angles of slopes and setting out grades.

Planimeter---for measuring area on the map.

Pentagraph---for enlarging or reducing area of the map.

Ceylon Chat tracer---for measuring angles of slopes and setting out grade contours.

Subtense bar---for measuring horizontal angles in stadia method.

Range finder or the line ranger---for ranging a chain line.

Hand level---for making contours, and cross-sections in preliminary work.

Q. What types of clinometers do you know of?
Ans

De Lisle's clinometer.
Watkins's mirror clinometer.
Foot rule clinometer.
Indian pattern clinometer.

Q. What are the expressions required in tape correction?

Ans There are five types of tape correction to be applied

- Correction for absolute length $C = \frac{L \times c}{l}$
- Correction for temperature $C_t = \alpha \times (T_m - T_0) L$
- Correction for pull (or tension) $C_p = \frac{(P - P_0) \times L}{AE}$
- (i) Correction for sag $C_s = \frac{l_1(w/l_1)^2}{24P^2}$
(ii) Normal tension $P_n = \frac{0.204W\sqrt{AE}}{\sqrt{P_0 - P_0}}$
- Correction for slope or vertical alignment $C_g = \frac{h^2}{2l}$

Q. State the instrument use for fixing direction and measuring angles.

Ans. 1. Prismatic compass 2. Surveyor's compass
3. Theodolite 4. Sextant

Q. What is the principle of compass surveying?

Ans. The principle of compass surveying is traversing, which means that the area is enclosed by series of connected lines, the magnetic bearings of these lines are taken with the compass and the distances of sides are measured by chain.

Q. State the use of Prismatic compass.

Ans. The Prismatic compass is usually used for rough surveys, for measuring bearings of survey lines. It is also used for sketching and right marching.

Q. What is the difference between triangulation and traversing

Ans. Triangulation involves dividing an area into a number of well-conditioned triangles. But traversing involves consideration of a series of connected lines.

Q. How are compensating and cumulative errors related to the lengths of a line?

Ans Compensating error $\propto \sqrt{L}$
Cumulative error $\propto L$

Q. What is the error due to incorrect ranging?

Ans Error in length = $d^2/40$ (for 20 m chain); = $d^2/60$ (for 30 m chain); where d is the amount of deviation.

Q. What is the permissible error in chaining?

Ans For ordinary work—1 in 1000
For precise work 1 in 2000.

Q. What is the angle between the mirrors in an optical square?

Ans The angle is 45 degree.

Q. On what measurements are chain survey and theodolite survey based?

Ans Chain survey is based on linear measurements, and theodolite survey on both linear and angular measurements.

Q. What is the fundamental difference between a prismatic compass and a surveyor's compass?

Ans A prismatic compass gives whole circle bearings from 0 to 360 degree, where as a surveyor's compass gives quadrantal bearings from 0 to 90 degree, with notations NE, NW, SE, and SW.

Q. What is the amount of dip at the equator?

Ans The amount of dip at the equator is zero.

Q. What are the isogenic and agonic lines?

Ans. An isogonic line is one passing through points of equal declination, whereas an agonic line connects points of zero declination.

Q. What is secular variation?

Ans. The variation of magnetic declination after every 100 years, similar to the oscillation of a pendulum is known as secular variation.

Q. What is the limit of precision in traversing?

Ans. The angular error of closure should not exceed $15' \times \sqrt{N}$ (N being the number of traverse legs) and the linear closing error should not exceed 1 in 600.

Q. Why it is called Prismatic compass?

Ans. It is called prismatic compass because a prism is provided in it for taking observations.

Q. What does the term 'Chain angle' mean?

Ans. When the angle between any two sides is fixed by chain and tape only by taking the line. The angle is said to be the chain angle.

Q. What is the fundamental difference between the prismatic compass and the surveyor's compass?

Ans. The prismatic compass show the whole circle bearing of a line, while the surveyor's compass show the quadrantal bearing of a line.

Q. What do you mean by azimuth?

Ans. The true bearing of a line is also known as its azimuth.

Q. What is the angular check of a closed traverse?

Ans. The sum of the interior angles should be equal to $(2N-4) \times 90^\circ$, where N is the number of sides of traverse.

Q. Give reasons for the following with respect to the construction of prismatic compass.

Zero is marked at south end of the needle.
Adjustable mirror is provided with the sight vane.

A pivot should be exactly at the centre and pointed sharp.
A sliding rider is provided on the central plate of graduated circle.

The agate cap is mounted on the graduated ring at the centre.

Hinged sunglasses are provided to the frame of reflecting prism.

The ball and socket arrangement is provided on the top of compass stand.

Ans. 1. When the needle is freely swinging on the pivot, it points towards North, and the reading under the prism should be zero. But since the prism is placed exactly opposite to the sight vane, the South end will be under the prism. Hence the zero mark must be placed at the South end of the needle. The bearings are thus obtained from North end in clockwise direction.

2. The adjustable mirror is provided with sight vane to take bearings of the objects which lie either above or below the line of sight.

3. A pivot should be exactly at the centre so that the difference of reading shown by the North and South ends of the needle should be exactly 180° . And pivot should be pointed sharp so that the magnetic needle will freely suspend on it and will show correct direction.

4. A sliding rider is provided on the central plate of graduated ring to balance the needle exactly in horizontal position.

5. The agate cap is mounted on the graduated ring at the centre which rests against the pivot. It enables the needle to move freely

6. Hinged sun glasses are provided to interpose into the line of sight when the sun or luminous objects are to be sighted. It acts as a goggle to the eyes of the observer.

7. The ball and socket arrangement is provided on the top of tripod stand by which the compass can be set in a horizontal position.

Q. How could you check the accuracy of open traverse?

Ans. The accuracy of open traverse is checked by taking cut off lines or an auxiliary point.

Q. State the function of in prismatic compass:
Brake pin

Prism cap**Lifting lever and lifting pin****Horse hair****Glass lid****Brass ring**

Ans. 1. Brake pin: To stop the undue fast movement of the graduated circle and allow it to stop while taking readings.

2. Prism cap: To protect the prism from dust.

3. Lifting lever and lifting pin: To protect the pivot point from undue wear. When the compass is not in use the sight vane presses against the lifting pin, which lifts the needle of the pivot and holds it against a glass lid, thus prevents undue wear of the pivot point.

4. Horse hair: To bisect the object while taking readings.

5. Glass lid: To see the graduations on the ring.

6. Brass ring: To keep the glass lid in position.

Q. Compass traversing is not reliable, Comment.

Ans. The magnetic needle of the prismatic compass is influenced by the presence of steel or magnetic substances in the vicinity. It does not point correct north direction under such circumstances and the reading observed may go wrong. Hence, the compass traversing is unreliable.

Q. State why the graduations on the ring in a prismatic compass are inverted.

Ans. These graduations are seen erect while looking through the prism. They are also seen magnified.

Q. Enlist the instruments used for measuring angles.

Ans. In engineering practice, the following instruments are used:

1. Prismatic compass
2. Surveyor's compass
3. Theodolite
4. Sextant

Q. What is use of a prism in a prismatic compass ?

Ans. The prism magnifies the portion of aluminium ring so that the reading can be taken properly.

Q. When will you use sunglasses of prismatic compass ?

Ans. When there is bright sun, sunglasses are used.

Q. What is the least count of prismatic compass ?

Ans. The least count of prismatic compass is 30 minutes.

Q. What is the use of mirror in prismatic compass ?

Ans. When the object is above or below the level of compass, it is not possible to bisect it directly. Then the mirror is so adjusted that the image of the object is obtained in the mirror and it is bisected.

Q. Give reasons for the following:

1. A pivot should be exactly at the centre and sharp pointed.

2. A ball and socket arrangement is provided on tripod stand of compass.

Ans. 1. A pivot should be at the centre to give errorless bearings and should be sharp pointed to carry the needle over it on one small point.

2. A ball and socket arrangement is provided on tripod so that it is easy to level the compass and therefore the ring does not touch the glass cover.

Q. Why lifting lever is provided in prismatic compass ?

Ans. Because it avoids unnecessary wear and tear of the pivot, thereby increasing its life.

Q. State the reason of marking the zero of the south end in case of prismatic compass.

Ans. The zero of the prismatic compass is marked on the south side because the prism is placed in the south side which is directly opposite to the object vane.

Q. State the purpose of writing inverted figures on the graduated circle of prismatic compass.

Ans. In prismatic compass the prism is used at eye vane and the observer looks at the reading through this prism. So to get the figures properly, it is in an inverted manner.

Q. Define bearing of lines.

Ans. The bearing of a line is the horizontal angle made by the survey line with some reference direction or meridian. The reference direction employed in surveying may be (a) a true meridian, (b) a magnetic meridian, (c) an arbitrary or assumed meridian.

Q. Explain the whole circle bearing system (W.C.B.) and Quadrantal Bearing system (Q.B.).

Ans. Whole Circle bearing system (W.C.B.): In this system the bearing of a line is measured clockwise from the north direction. It is called a whole circle bearing (W.C.B.). The value of the angle ranges from 0° to 360° .

Quadrantal Bearing system: In this system bearing of a line is measured clockwise or anticlockwise from the north to south direction whichever is nearer the line, towards east or west.

It is, therefore, essential to state the quadrant in which the line lies. The letters N (north), S (south), E (east) and W (west) are used to represent the quadrant.

Q. What is the maximum value of bearing in W.C.B. and Q.B. systems?

Ans. In W.C.B. system the maximum value of bearing is 360° . In

Q.B. system the maximum value of bearing is 90° .

Q. Define reduced bearing.

Ans. When the whole circle bearing of a line exceeds 90° , it must be reduced to the corresponding angle less than 90° which has the same numerical values of the trigonometrical functions. This angle is known as the reduced bearing (R.B.)

Q. Does the local attraction affect included angles?

Ans. No. Because both the readings are taken from the affected stations. The errors compensate each other and the correct angle is obtained.

Q. Define: (a) Annual variation, (b) Secular variation.

Ans. (a) Annual variation: If the variations are taken for the whole year, then the variation will be 1 to 12 minutes with respect to the true north.

(b) Secular variation: The magnetic meridian swings like a pendulum. It swings in one direction of the true north for many years, even 100 to 150 years, comes to rest gradually, coinciding with the true north and again swings in the opposite side of it.

Q. Enlist the steps involved in chain and compass survey.

Ans. Steps involved in chain and compass survey are:

1. Reconnaissance
2. Marking and referencing stations
3. Running of survey lines
4. Picking up of details
5. Booking of field notes
6. Taking out bearing of survey lines
7. Plotting a traverse.

Q. How will you select survey stations for compass traverse?

Ans. The survey stations should be so selected that:

1. They are mutually visible
2. Chaining between them is easy.
3. The lines joining the stations are as near the boundaries and objects to be located as possible.
4. They are as long as possible.

Q. How is local attraction detected?

Ans. Detection of local attraction: The local attraction can usually be detected by observing the bearing (F.B. and B.B.) of a line at two or more points on the same line.

If the difference between fore and back bearing of the line is exactly 180° , there is no local attraction at either point. If not, local attraction is suspected at either station or both. Care should be taken that there is no observational or instrumental error.

Q. State the use of prismatic compass.

Ans. Use of prismatic compass: It is used for survey in wooded country, rough traverses, filling in details, preliminary surveys for

roads, railways. It is also used for sketching and right matching. It is unreliable in areas with magnetic rocks or iron ore. It is less accurate than theodolite.

Q. Explain centering and levelling of prismatic compass

Ans. Centering: Centering is the process of keeping the instrument exactly over the station. It is carried by dropping a small piece of stone so that it falls on the top of the pegs fixed at the station point.

Levelling: It is levelled by means of ball and socket arrangement so that the graduated ring may swing freely. The instrument is then clamped.

Q. Write a short note on magnetic declination.

Ans. The magnetic declination: The magnetic meridian at a place does not coincide with the true meridian at that place. In some cases the magnetic meridian is deflected to the east side of the true meridian while in others it points to the west of the true meridian. The horizontal angle made by the magnetic meridian with the true meridian is called magnetic declination. The magnetic meridian varies from place to place and also from time to time on the surface of the earth and hence, the declination is also different at different places.

Q. How will you calculate true bearing at a place whose magnetic declination is known?

Ans. A place whose magnetic declination is known at the time of observation. Then the true bearing may be determined by the following rule:

- (a) True bearing of line = magnetic bearing of line $\pm$ declination
Use $+$ ve sign when declination is towards east.
Use $-$ ve sign when declination is towards west
- (b) Bearing of line = magnetic bearing of line $\mp$ declination

Q. Write a note on limits of precision in compass surveying.

Ans. In the case of prismatic compass the least value that can be estimated is 30 minutes and therefore, the permissible error per bearing should never exceed this amount. The angular error of

closure or summation error in minutes should not exceed $30\sqrt{N}$ where N is the number of stations or sides of a traverse. The relative error of closure should be between 1 in 300 to 1 in 600.

Q. What is an azimuth?

Ans. The true bearing of a line is known as the azimuth of that line.

Q. What is a trunnion axis?

Ans. The horizontal axis about which a telescope can be rotated in a vertical plane is known as a trunnion axis.

Q. What is the difference between a magnetic meridian and a true meridian?

Ans. A magnetic meridian represents the line indicated by a freely suspended magnetic needle. At true meridian represents the line passing through the geographical north and south poles.

Q. What is the nature of true meridians at different places?

Ans. True meridians are not parallel at different places. They converge from the equator towards the pole.

Q. What are grid lines?

Ans. The assumed meridians parallel to the true meridian at a place are known as grid lines.

Q. What types of telescopes do u know of?

Ans. 1. The external focusing telescope-here the object glass moves to and fro.
2. The internal focusing telescope- here a double concave lens is geared with the focussing screw by means of a rack-and-pinion arrangement which moves to and fro with the turning motion of the screw.

Q. On which factors does the sensitiveness of a bubble depend?

Ans. The sensitiveness of a bubble depends on the viscosity and surface tension of the liquid.

Q. What is the angular value per division of deflection?

Ans Angular value, $\alpha' = d/R \times 206,265$ seconds

Where d = length of one division and
 R = Radius of curvature.

Q. What does the term, magnification power, mean in the context of a telescope?

Ans The ratio of the focal length of the object glass to that of the eye-piece is known as magnifying power. That is, $MP = f/f'$

Where f = focal length of object glass.

And f' = focal length of eye piece.

This is expressed in terms of diameter, e.g. 20 dia, 30 dia, etc.

Q. Give a practical example of level surface?

Ans The water surface of still a lake is one such example.

Q. State the use of level.

Ans. The level is used to furnish horizontal line of sight for observing staff readings by means of which the elevations (R.L.S.) of the points are determined.

Q. Give the meaning of the following terms used in levelling.

Mean sea level.

Axis of telescope.

Line of collimation.

Axis of bubble tube.

Vertical axis.

Ans. 1. Mean sea level is the average height of the sea for all the stages of tides. It is observed by averaging the hourly tide heights over a long period of 19 years at a place.

2. Axis of telescope is the line joining the optical centre of the object glass to the centre of the eye piece.

3. Line of collimation is the line joining the centre of diaphragm to the optical centre of the object glass and its continuation. It is also known as line of sight.

4. Axis of bubble tube is the imaginary line tangential to the longitudinal curve of the bubble tube at its mid-point. It is horizontal when the bubble is in centre.

5. Vertical axis is the axis about which the telescope of level rotates in horizontal plane.

Q. What is a datum surface?

Ans. A datum surface is an arbitrarily assumed level surface from which the vertical distances of various objects are measured.

Q. What does the term 'GTS' means?

Ans. GTS means the Great Trigonometrical survey.

Q. What are Benchmarks?

Ans. A reference point whose RL is fixed with respect to the datum surface is known as a bench mark. It is a point of known RL.

Q. What is the datum adopted for GTS Bench Mark?

Ans. The mean sea level at Karachi is adopted as the datum for GTS Bench Mark. It is considered as zero.

Q. What are the types of B.M. that you know?

Ans. Four Types:

1. GTS BM

2. Permanent BM

3. Temporary BM

4. Arbitrary BM

Q. What is meant by parallax and how it is removed?

Ans. Parallax is the apparent movement of the image relatively to the cross-hairs when the image formed by the objective does not fall in the plane of cross-hairs or diaphragm. It can be removed completely by exact focussing.

Q. For any engineering work, how will you get the RL of the starting point?

Ans. The starting point is connected to the GTS or permanent BM by fly levelling. The RL of starting point is calculated by usual method.

Q. What is the difference between a level surface and a horizontal surface?

Ans. A surface parallel to the mean spheroidal surface of the earth is known as a level surface. But a horizontal surface is tangential to the level surface at any point. The surface of still lake is considered to be level surface. The surface perpendicular to the direction of gravity (indicated by a plumb line) is considered to the horizontal.

Q. State two types of level.

Ans. 1. Dumpy level, and 2. Tilting level

Q. The staff readings on A and B are 1.825 and 0.985 respectively. Which point is higher ?

Ans. Point B is higher.

Q. How is level centered ?

Ans. In a levelling operation, the level is never centered. It can be set up at any suitable position. The level is centered only when the magnetic bearing of any line is taken with the compass attached to the levelling instrument.

Q. Suppose a level is given to you whose line of collimation is not in adjustment. What is the procedure that you would follow in order to work with this instrument ?

Ans. The principle of equalizing backsight distances should be followed. This means the level should always be placed exactly midway between BS and FS.

Q. How will you continue levelling across a river ?

Ans. Reciprocal levelling should be adopted across a river.

Q. Which level you will use under the following situations. Give reasons for your choice.

A. Bench Mark is to be carried from a point M to N, 1000m distant.

Numbers of staff readings are to be taken from one set up to the level.

Ans. 1. With a tilting level: While carrying a bench mark from one place to another, the level has to be shifted every time after taking backsight and foresight. Tilting level sets quickly and hence it is

advantageous as compared to dumpy level which needs more time for setting and levelling.

2. With a dumpy level, number of staff readings can be taken in different directions with a single levelling station. Where as tilting level has to be levelled for every staff reading.

Q. How will you continue levelling across a lake or pond ?

Ans. We know that the water surface of a lake or pond is level. So, two pegs are fixed on opposite banks finish with the water surface. Then the FS reading is taken on one peg and RL is calculated. After this, a BS reading is taken on the other peg. As the water surface is level, the RL of the second peg is assumed to be equal to that of first peg, and the levelling operation is continued.

Q. What is the arithmetic check for HI method and the Rise and Fall method ?

Ans. Arithmetic check for HI method is

$\Sigma BS - \Sigma FS = \text{Last RL} - \text{First RL}$

Arithmetic check for rise and fall method is

$\Sigma BS - \Sigma FS = \Sigma \text{Rise} - \Sigma \text{Fall} = \text{Last RL} - \text{First RL}$

Q. What is fly levelling ?

Ans. The levelling operation in which only BS and FS readings are taken and no intermediate sights are observed is known as fly levelling.

Fly levelling is done for connecting the BM to the starting point at any project.

Q. State the temporary adjustment of dumpy level. How it differs from that of tilting level ?

Ans. Temporary adjustments of dumpy level are:

Setting up the level over the tripod.

Levelling up.

Focussing the eye piece.

Focussing the object glass to remove the parallax.

In case of tilting level, the main bubble is brought to the centre by

micrometer screw for every staff reading.

Temporary adjustment of tilting level:

Setting up. Bring all the foot screws to the centre of their run. Bring the circular bubble to the centre by tripod legs.

Focus the eye piece.

Direct the telescope towards the staff and focus it. Bring the main bubble exactly to the centre by means of micrometer or Tilting screw. No other screw should now be touched for centering the main bubble.

Q. What is check levelling ?

Ans. In case of longitudinal levelling, at the end of the day's work the finishing point is connected to the starting point of the day's work by the levelling to the check the accuracy of the work. The operation is known as check levelling.

Q. What do you mean by positive RL and negative RL ?

Ans. The vertical distance of a point above the datum surface is known as the positive RL and the vertical distance below the datum surface is said to be the negative RL.

Q. How will you measure the distance between two points with only a level and staff?

Ans. The distance can be measured by the stadia method. The difference of stadia hair readings is multiplied by 100 (stadia constant) to get the required distance.

Q. What is contour line ?

Ans. A line joining points of equal elevation is known as contour line.

Q. State the least count of levelling staff ?

Ans. L.C. of levelling staff is 5mm or 0.005m.

Q. Describe the method of marking on the levelling staff ?

Ans. Each meter is subdivided into 200 division to read to the accuracy of 5mm. Every decimeter length is figured with the corresponding numerals. This meter's numeral is marked in red and decimeter numeral in black. When extended the total length of

telescopic levelling staff is 3 metre. The graduations are marked erect.

Q. State the types of telescopes used in levels.

Ans. (a) External focussing and (b) Internal focussing

Q. How would you know the type of telescope in a given level.

Ans. The type of telescope can be known by operating the focussing screw of the given instrument. If the length of telescope changes, it is an external focussing type while if the length of telescope remains constant it is internal focussing type of telescope.

Q. State the advantages of internal focussing telescope over an external focussing telescope.

Ans. The main advantages of internal focussing telescope are: The interior of the telescope is free from dust and moisture. It is well balanced. The line of collimation is less likely to be affected by focussing. The overall length of telescope is short as compared to the external focussing telescope.

Q. Describe the construction of object glass ?

Ans. It is compound lens consisting of (a) an outer double convex lens made of crown glass, and (b) an inner concave convex lens made of dense flint glass. Two serious defects are eliminated by this compound lens viz, spherical aberration and chromatic aberration.

Q. State the type of eye piece used in level. Describe its construction and object.

Ans. Ramsden Eyepiece is used.

It is composed of two equal Plano-convex lens of equal focal length. They are placed with their convex side towards one another, at a distance of two third of the focal length of either lens. It is placed at a distance of one forth the focal length of either lens from the diaphragm. The image formed by this eye piece is

inverted. The object of eye piece is to magnify both the image and the cross-hairs of the diaphragm.

Q. What is stadia diaphragm? Where it is used?

Ans. The diaphragm having three horizontal lines and one or two vertical or inclined lines is known as stadia diaphragm. It is used in tachometric surveying. Now a days such type of diaphragm are also provided in levels.

Q. State the precautions you will take while taking out the instrument from the box?

Ans. Before taking out the instrument from the box, mark the position of (a) object glass, (b) eye piece and (c) clamp and tangent screw etc. So that it can be placed easily in box in its proper position after the use.

Q. State the fundamental axes of level and give their desired relationship in dumpy level?

Ans. The fundamental axes of the instrument are:

The vertical axis.

The axis of bubble tube.

The line of collimation.

The axis of telescope.

Desired relationship in Dumpy level:

The axis of bubble tube should be perpendicular to the vertical axis.

The line of collimation should be parallel to the axis of bubble tube.

Q. Name the types of benchmark established by:

(a) Government agencies as P.W.D.

(b) Survey of India Department

Ans. (a) Government agencies as P.W.D.: Permanent Benchmark

(b) Survey of India Department: G.T.S. Benchmark

Q. Where will you use a ray shade?

Ans. To prevent direct rays entering into the telescope, ray shade is used.

Q. What is the least count of telescopic staff and folding staff?

Ans. The least count of both the staffs is 5 mm or 0.005m.

Q. Define the term 'reduced level' or 'elevation'.

Ans. It is a height or depth of any point above or below any datum. It is known as reduced level (R.L.) or elevation of a point. The elevations of a point is plus or minus according as the point is above or below the datum.

Q. What is meant by dumpy level?

Ans. Dumpy means short and sturdy. That is why the name dumpy level.

Q. What is the use of dumpy level?

Ans. To take vertical measurements, which gives the nature of the field.

Q. How will you judge the telescope is either internal focussing or external focussing?

Ans. Move the focussing screw. If you see either the eyepiece or the objective is moving, then it is external focussing telescope. If you do not see any movement, then it is an internal focussing telescope.

Q. How is focussing done in internal focussing telescope

Ans. A double concave lens is provided between the diaphragm and object glass. When you move the focussing screw, this lens moves and the distance between the object glass and double concave lens is so adjusted that the image of the staff is formed on the diaphragm.

Q. When will you move the capstan headed nuts?

Ans. At the time of permanent adjustment, to bring the bubble at the centre, the capstan headed nuts are moved.

Q. State the permanent adjustment of dumpy level.

Ans. Permanent adjustments of dumpy level are:

(a) To make the axis of bubble tube perpendicular to the vertical axis.

(b) To make the line of collimation parallel to the axis of the bubble tube.

Q. What is I.O.P.?

Ans. A tilting level is also known as I.O.P. level (Indian office pattern). In this level the telescope tilts about a horizontal axis just below it and hence it is called tilting level.

Q. Explain the suitability of tilting level.

Ans. This level is suitable for precise levelling. It is suitable when only few staff readings have to be taken at each set up.

Q. State the purpose of focussing the eyepiece and object lens.

Ans. Object lens is used for removing parallax while eye piece is used to make cross hairs on diaphragm very clear, so that observations can be taken without difficulty.

Q. What information will you get from profile levelling

Ans. Profile levelling gives the following information:

1. Nature of ground.
2. Original ground levels.
3. Formation level.
4. Finished surface level.
5. Depth of cutting and height of filling.
6. Proposal gradient.
7. Any other information which is likely to be useful during the execution of the work.

Q. Enlist the errors involved in levelling.

Ans. The errors in levelling are due to the following principle sources:

1. Instrumental error.
2. Error of manipulation.
3. Imperfect sighting.
4. Errors due to settlement of staff and level stand.
5. Errors due to natural sources.

Q. Give the value of permissible closing error for precise levelling and accurate levelling.

Ans. Permissible closing error (E) for:

1. Precise levelling: $E = \pm 6\sqrt{K}$
2. Accurate levelling: $E = \pm 12\sqrt{K}$
3. For very high precision: $E = \pm \sqrt{K}$

Q. Define the term benchmark. Give the types of benchmarks.

Ans. Benchmark: It is a fixed reference point of known elevation. It is used either as a starting point for levelling or as a check while closing.

Types of Benchmarks: There are four kinds of benchmarks (B.M.):

1. Great Trigonometrical survey benchmark (G.T.S.)
2. Permanent benchmark
3. Arbitrary benchmark
4. Temporary bench mark

Q. What is the difference between temporary adjustment and permanent adjustment?

Ans. Temporary adjustments such as levelling, focussing eyepiece and object glass are carried out for every set up of the instrument. The line of collimation is perpendicular to the vertical axis and parallel to the axis of the bubble tube or permanent adjustment. These adjustments remain undisturbed for a long time. Hence they are called permanent adjustments.

Q. State the fundamental lines of dumpy level and express the relationship between them.

Ans. The fundamental lines of dumpy level are:

- a. Line of collimation
- b. Axis of bubble tube
- c. Axis of telescope
- d. Vertical axis

Relationship between these lines:

1. Axis of bubble tube should be perpendicular to the vertical axis.

2. Line of collimation should be parallel to the axis of the bubble tube.
3. Axis of telescope and line of collimation should coincide.

Q. What is meant by parallax ? Why does it appear? How will you remove parallax on head ?

Ans. Parallax: It is the apparent movement of the image relatively to the cross hairs when the image formed by the objective does not fall in the plane of the diaphragm.

It is due to poor focussing of the objective. It can be tested by the eye up and down.

The parallax can be eliminated entirely by focussing the objective correctly. This can be done first by focussing the eyepiece for distant vision of the cross hairs and then by focussing the objective.

Q. How will you check verticality of a staff ?

Ans. (a) In precise levelling the staff is equipped with a circular bubble at its back to hold it exactly in plumb.

(b) In ordinary levelling, the staff is waved slowly forward and backward, and the minimum reading is taken to avoid the errors.

Q. Write a short note on profile levelling.

Ans. Profile Levelling: It is necessary to know the accurate outline of surface of the ground along a given line. The levels are taken at some regular intervals. It is also called longitudinal levelling.

Q. Explain the following terms:

1. Cross sectioning, 2. Fly levelling

Ans. Cross sectioning: It is an operation of levelling to know the undulation of ground surface at right angle to given line on either side of it.

Fly levelling: When you want to establish the temporary bench mark near the site, then levelling work is started from the nearest permanent B.M. and by taking only B.S. and F.S. the R.L. of T.B.M. is found out. This is known as taking fly level. It is also

used after finishing the day's work. The last point is connected to the starting point by fly level for checking the work.

Q. What is closing error in levelling ?

Ans. Closing error in levelling: The levelling work is generally started from a point of known reduced level (B.M.) and after carrying out the required levelling the work is finally closed on the starting point by taking foresight on it. The difference in reduced level, of the starting point indicates the closing error in levelling. The magnitude of permissible closing error may be expressed as:

$$E = C\sqrt{K}$$

Where E = the permissible error in millimeters

C = the constant

K = Distance in kilometers

For ordinary levelling $E = \pm 24\sqrt{K}$

For rough levelling $E = \pm 96\sqrt{K}$