MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)

(ISO/IEC -270001 – 2005 certified)

WINTER -2016 EXAMINATION

Subject code: 17419 **Model Answer**

Important Instructions to examiners:

1) The answer should be examined by keywords and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language error such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skill).

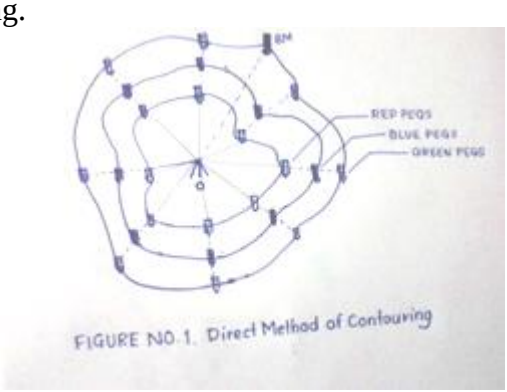
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In the some cases, the assumed constants values may vary and there may be some difference in the candidates answer and model answer.

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding

Question and Model Answers	Marks
Q.1 a) Attempt any SIX of the following:	**12**
(i) State the uses of contour maps.	
Uses of contour maps: i) The nature of the ground surface of a country can be understood by studying a contour map. ii) A suitable site or an economical alignment can be selected for any engineering projects. iii) The capacity of a reservoir or the area of catchment can be determined approximately. iv) The inter visibility between (or route joining) different points can be established. v) A suitable route for a given gradient can be marked on the map. vi) A section of the ground surface can be drawn any direction from the contour map. vii) Quantities of earthwork can be determined approximately. ***(Note- 1 mark each any two)***	**2***
(ii) Define 1) Contour 2) Contour Interval	
Contour :- It is an imaginary line on the ground joining points of equal elevation or RLs. **Contour Interval :-** The vertical distance between any two consecutive contours is known as a contour interval	**1** **1**
(iii) Define Grade contour.	
Grade contour :- It is the contour established on a specific grade or gradient along the hill side. **OR** The line joining the points of equal grade or gradient is called as grade contour.	**2**
(iv) Define 1) Telescope inverted 2) Telescope normal	

Telescope Inverted :- It means bubble down & the face right position is called telescope inverted. **Telescope Normal :-** It means bubble up & the face left position is called as telescope normal.	**1** **1**
(v) Define the term departure and latitude	
Departure :- It is the distance parallel to the East-West line **OR** the projection of survey line perpendicular to the meridian is called departure. **Latitude :-** It is the distance parallel to the North-South line **OR** the projection of survey line parallel to the meridian is called latitude.	**1** **1**
(vi) What are the different fundamental axes of theodolite?	
Fundamental axes of theodolite :- 1) Line of collimation 2) Vertical axis 3) Axis of telescope 4) Axis of bubble tube or bubble axis 5) Horizontal axis. ***(Note- 2 marks for any four)**	**2***
(vii) State any two advantages of total station over dumpy level and theodolite.	
Advantages of total station over dumpy level and theodolite :- 1) Total station gives digital measurements of sloping, horizontal and vertical distances accurately and precisely. 2) Total station gives digital measurements of vertical and horizontal angles accurately and precisely. 3) Total station consists of electronic field book to record the data and additional information. 4) Total station is used for speedy completion of any type of project work. 5) Total station provides the provision of uploading and downloading the data to computer. 6) Total station used to prepare the map and drawings using softwares. ***(Note- 1 mark each for any two)**	**2***
(viii) State the two methods of setting out curves.	
Methods of setting out curves :- 1) Method of offsets or ordinates from the long chord 2) By successive bisection of arcs 3) By offsets from tangents 4) By offsets from chords produced 5) Rankine's method of tangential angles 6) Two Theodolite method ***(Note- 1 mark each for any two)**	**2***
Q.1 b) Attempt any <u>TWO</u> of the following:	**8**
(i) State the methods of locating contours and explain direct method.	**4**
Methods of locating contours :- 1) Direct method 2) Indirect method i) By cross section ii) By Squares (Block Contouring) iii) Tachometric Method **Direct method of contouring**:- In this method of contouring, the contours of required reduced level are plotted on ground itself. The procedure of direct method of contouring is as follows. 1. Set the level instrument at the center O as shown in figure 1 and do all temporary adjustments like levelling and focusing. 2. Take the first reading on bench mark (Reduced Level i.e. R.L. 100 m) as back sight reading (Say 1.200 m), so that R.L. of instrument axis will become 101.200 m. 3. If the contour of 100 m is required to plot, then reading on staff should be 101.200 – 100 = 1.200 m.	**1** **2**

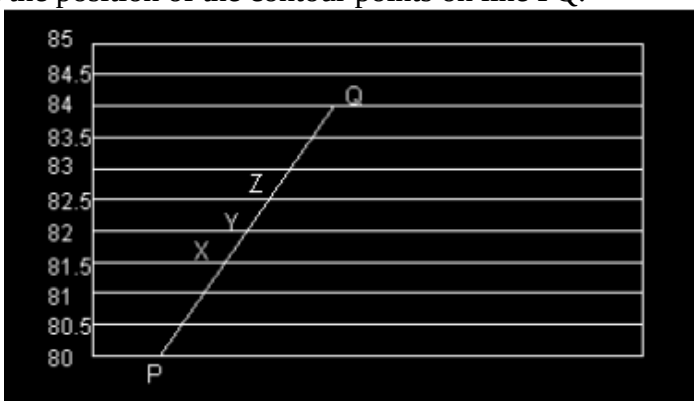
4. This reading of 1.200 m is searched in radial directions (say 300 around instrument station O) by looking through telescope of level instrument. Once these points are found out, then they are marked with red coloured pegs. 5. Similarly, to set 99, 98, and 97 m contour, the reading on staff should be 2.2, 3.2 and 4.2 m respectively. These all contours can be searched in same radial directions and then marked with blue, green and yellow coloured pegs respectively. 6. By joining these identical coloured pegs, we get the required contours on ground by this direct method of contouring.  FIGURE NO 1. Direct Method of Contouring	**1**
(ii) State the application of remote sensing in various fields.	**4**
Applications of remote sensing:- Remote sensing is widely applicable in the following areas. **1) Applications of Remote sensing with respect to natural hazard.** e. g In case of flood ,earthquake ,volcano eruption and related hazards, land slides, Tsunami, cyclone, etc. **2) Environmental application**: Series of satellite used for weather forecast i.e. cyclone, cloud, wind velocity, sea states, pollution, global warming, and ozone layer depletion. **3) Land use and land cover Analysis**: Land use for Urban purpose agricultural sea forest etc. particular cropping pattern, spread area. **4) Archaeology**:-To recognize archaeological patterns of prehistoric land use, buried archaeologically important sites. **5) Revision of topo sheets**: Rapid revision and updating of existing topo sheets (maps) with help of aerial photography and satellite imagery survey of India department undertake such work. **6) Alignment of (new) highways and rail-lines**: - By using aerial photographs and satellite imagery location of most economical alternative sites of such works may be carried out easily. **7) Location of gravity dam sites** :- Geological investigation of dam site can be carried at using aerial photographs and satellite imagery (Geological features such as folds, faults, dykes, fractures, rock type) **8) Tunneling**: - Geological information (i.e. Faults & fractures) along alignment of tunnel is furnished by aerial photographs and satellite imagery to ensure safety during construction and maintenance of funnel. **9) Silting of storage reservoir, harbors etc**.:- Satellite gives imagery idea about silting of reservoir (reduces reservoir capacity) qualitatively and quantitatively and silting of harbor (reduces navigational depth). **10) Location of percolation tanks**: To locate exact location of percolation tank from geological investigation of permeable foundation to increase ground water table by using satellite imagery. **11) Seepage losses in canal**: By careful study of aerial photograph and satellite imagery, soil moisture in and around the canal system can be monitor and identify the seepage through the canal **12) Location of bridge site:** Careful study of aerial photograph and satellite imagery used	**4***

to analyze existing foundation conditions along the proposed bridge construction site. To find economic and safe alignment of bridge. **13) Study of catchment and command area of dam site**: Aerial photographs and satellite imagery used to ascertain the catchment area and command area of dam site. **14) Mineral exploration:** Detailed exploration of non –renewable resource like minerals and fossil fuels, geological data, location of minerals, mapping of mineral zones. ****(Note- 1 mark each for any four)***	
(iii) Describe the temporary adjustment of theodolite.	**4**
Temporary adjustment of theodolite:- The following operations should be done as temporary adjustments before taking readings on any theodolite. **1. Setting of theodolite on tripod stand** – The theodolite should be fixed by rotating its screw head on top of tripod stand. The legs of tripod stand should be fixed on ground very firmly to ensure safety of theodolite and easiness in taking observations. **2. Centring of theodolite over prefixed survey station** – The centring of theodolite can be done by either dropping stone or suspending plumb bob from bottom of tri-batch plate. Then it made to match over nail point of station peg by adjusting one of the legs. In some theodolite, optical plummet is provided for this centring. **3. Levelling of theodolite in horizontal plane** – By keeping horizontal plate bubble tube (HPBT) parallel to any two foot screws, both are rotated inward or outward simultaneously to bring the bubble at center. Then by keeping HPBT perpendicular to original position, the third foot screw is rotated inward or outward to bring the bubble at center. These should be continued till in both positions, bubble of HPBT remains at center. Once bubble remains at center, levelling of theodolite is said to be completed. **4. Focussing of telescope** – The focusing of telescope is done to remove parallax. First eyepiece screw is rotated to see clear image of cross-hairs. Then focussing screw is rotated to see clear image of object. Once both images (i.e. cross hairs and object) simultaneously focussing of telescope is said to be completed. ****(Note- 1 mark for each step)***	**4***
Q.2 Attempt any <u>FOUR</u> of the following:	**16**
a) State the methods of contour interpolation and explain in brief any one.	**4**
Methods of interpolation:- i) By Arithmetic calculations ii) By Estimation iii) By Graphical method **i) By Arithmetic Calculation**: This is very tedious but accurate method and is used for small areas where accurate results are necessary. The contours are interpolated as under: Suppose A and B are two points at a distance of 30 m and the reduced level of A and B are 25.45m and 27.54m respectively .Taking the contour interval as 1m, 26 and 27 m contours may be interpolated in between A and B. The difference of level between A and B is 2.09m.the difference of level between A and 26m, and A and 27m is 0.55m and 1.55 m respectively. Therefore the horizontal distance between A and 26 m contour =0.55/2.09 x 30m and Between A and 27 m contour =1.55/2.09 x 30m. These distances are then plotted to scale on the map . **ii) By Estimation Method** **1.** Contour points are estimated by judgment and marked .The contour lines are then drawn through these points. **2.** This method is rough and is suitable for small scale works	**1** **3***

3. This points located by judgment is not accurate as located by arithmetic calculations

iii) By Graphical Method

Several lines are drawn parallel to each other on a tracing paper say at an interval of 0.5 m. in fig the bottom most line represent an elevation of 80.00m and if it is required to interpolate contour of 81.5,82 and 82.5 between a line PQ of an elevation of 80.00m and 84.00 m then keep the tracing paper on the line in such a way that point P may lie on a parallel representing an elevation of 80.00 m. Now, rotate the tracing paper on drawing in such a way that point Q may lie parallel representing an elevation of 84.00m. The points at which the parallel representing 81.5, 82.0 and 82.5m (shown by X, Y, Z in fig.) may now be pricked through the position of the contour points on line PQ.



(Note- 3 marks for any one method)

b) Differentiate between trapezoidal and prismoidal formula for computation of volume. **4**

Sr.No.	Trapezoidal Formula	Prismoidal Formula
1)	This formula is suitable for any number of sections.	This formula is applicable when there are an odd number of sections.
2)	**Trapezoidal formula** V = D/2(A1+An+2(A2+A3+….+An-1)) Where D=Common distance A1=Area of first section An=Area of last section A2,A3,..An-1=Area of all other sections	**Prismoidal formula** V = D/3 (A1+An+ 4(A2+A4++An-1) + 2(A3+A5+…+An-2)) Where D=Common distance A1=Area of first section An=Area of last section A1,A3,..An-1=Area of odd sections A2,A4,..An-2=Area of even sections
3)	In this method area is divided into series of trapezoids.	In this method area is divided into series of prismoids.
4)	The trapezoidal formula does not give the correct volume.	Prismoidal formula gives more correct volume due to prismoidal consideration.
5)	Simple in calculation.	Comparatively difficult calculation.
(Note- 1 mark each for any four)		

4*

c) The following readings were recorded by a planimeter with the anchor point inside the figure. IR=9.377, FR=3.336, M=100 cm^2 and C=23.521. Calculate the area of the figure when it is observed that the zero mark of the dial passed the index mark once in the anticlockwise direction. **4**

Given - IR=9.377, FR=3.336, M=100 cm^2 and C=23.521(inside the figure), N=-1(anti clockwise) **1**

Area of the figure: A= M (FR – IR $\pm$10N + C) **1**

A = 100(3.336-9.377-10x1+23.521) **1**

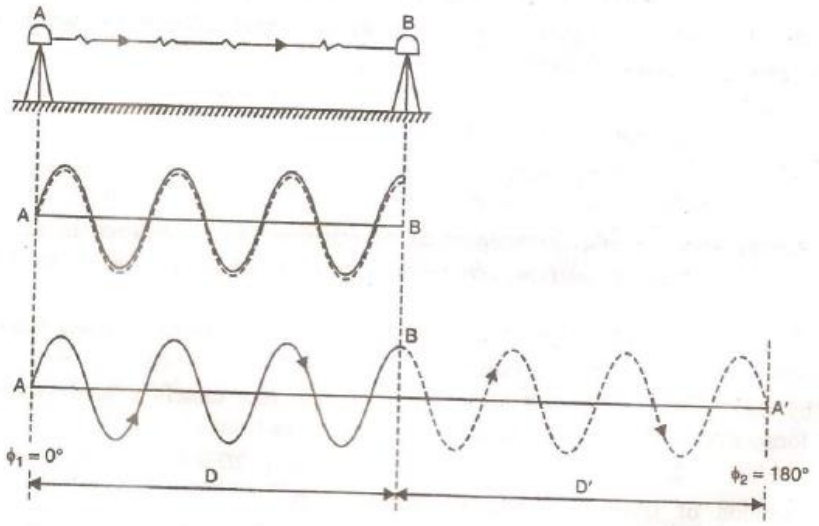
A=748 cm^2	**1**
d) State the limitations of tacheometry.	**4**
Limitations of tacheometry:- 1) Less accurate method and chaining is completely eliminated. 2) This method is not suitable for precise survey. 3) It has been recommended that error in single horizontal distance should be in 1 in 500. 4) Small error in observing stadia rod gives large error in calculation of horizontal distance and RL. Therefore method is used for relatively small precision job. ***(Note- 1 mark each)***	**4***
e) Compare theodolite traversing by included angle method with deflection angle method. Which one is suitable?	**4**

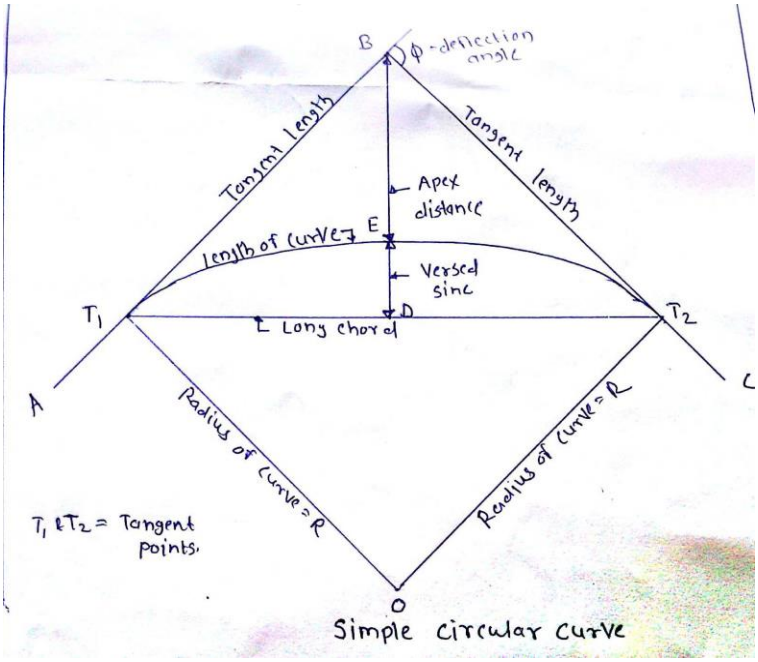
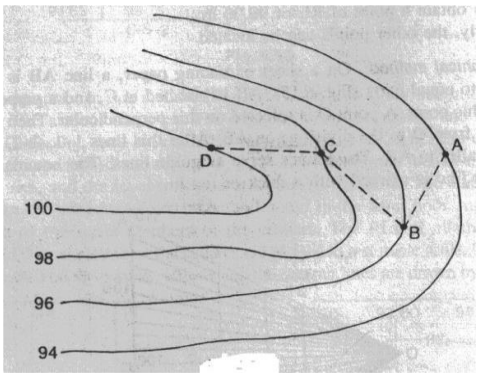
Sr.No.	Included angle method of traversing	Deflection angle method of traversing
1)	This method is most suitable for closed traverse.	This method is most suitable for open traverse.
2)	The traverse may be taken in clockwise or anticlockwise order.	The traverse is proceeded in the direction of survey only.
3)	Included angles of traverse are measured and check is applied as below- Sum of measured internal angles should be equal to $(2N-4) \times 90^0$ Sum of measured exterior angles should be equal to $(2N+4) \times 90^0$	Deflection angles are measured. Checks can be applied with some field measurements, tie line or cut off line and auxiliary points.
4)	This method is suitable for small scale area e.g. buildings	This method is suitable for long narrow strip like survey of roads, rivers, canals, railways, etc.
(Note- 1 mark each)		

4*

f) Mention different sources of errors in theodolite surveying.	**4**
Sources of errors in theodolite surveying:- **i) Instrumental errors-** 1) Non adjustment of plate bubble. 2) Line of collimation not being perpendicular to horizontal axis. 3) Line of collimation not being parallel to axis of telescope. 4) Horizontal axis not being perpendicular to vertical axis. 5) Eccentricity of inner and outer axes 6) Graduations not being uniform. 7) Verniers being eccentric. **ii) Personal errors-** 1) Imperfect centering and leveling. 2) Improper fixing of clamps. 3) Improper use of tangent screws. 4) No parallax removing. 5) No accurate bisecting. 6) Verniers may not set in proper place. 7) Over sighting in reading vernier. **iii) Natural errors-** 1) High temperature causes error due to irregular refraction. **2)** High winds cause vibration in instrument. ***(Note- 1 mark each for any four)***	**4***

Q.3 Attempt any FOUR of the following:	16
a) Explain the procedure adopted with micro optic theodolite to find reduced level.	**4**
Procedure adopted with micro optic theodolite to find reduced level: 1) Take out micro optic theodolite from its box and fix it on the tripod over the required station. 2) Carryout the approximate leveling by leg adjustment and centering by judgement. 3) Accurate centering with help of optical plulmmet. 4) Levelling is done with help of foot screws and plate level. 5) Focussing and sighting by using ring on the eye piece to get clear image of cross hair and focusing sleeve on telescope to get clear image of the object. 6) Open the illumination mirror and turn it towards the light to get the circle evenly illuminated. 7) Setting initial vertial angle zero-zero by using vertital circle drive, for keeping the line of collimation perfectly horizontal. 8) Reduced level of any point is find out by the usual procedure. i.e. taking first staff reading on bench mark and then on each other required points. 9) Readings are recorded in field book. 10) RLs can be obtained by line of collimation method or Rise and fall method.	**1** **1** **1** **1**
b) State four component parts of digital theodolite and state their purpose.	**4**
Component parts of digital theodolite and their purpose: 1. Control panel: to perform operations by giving commands to measure horizontal and vertical angles in left or right direction, to switch on or off the instrument. 2. LCD screen : to get the display of results. 3. Horizontal clamp and slow motion screw: to control the movement of telescope in horizontal plane. 4. Vertical clamp and slow motion screw: to control the movement of telescope in vertical plane. 5. Rechargeable battery: To provide the power to operate electronic circuit of instrument. 6. Compensator: For automatic fast and steady leveling. 7. Foot screws: for leveling of instrument by usual method. ***(Note- 1 mark each for any four)***	**4***
c) How the layout is done using total station?	**4**
Layout total station: 1. On the plan supplied by an architect, number the column serially from left to right and top to bottom starting from top left corner. 2. Work out coordinates of column centre with respect to one plot corner or well defined point, assuming line parallel to any one face of building as meridian. 3. Create an excel document with 4 independent columns one for column number and rest three for N, E & H coordinates. Upload this file to total station by using transfer software provided with instrument. 4. Set the total station at site at a point with respect which the coordinates of column centre are work out. Initiate the total station by proving with the coordinates of station and by orienting the telescope along the reference meridian. 5. Now, activate the setting out programme of the total station. Open the uploaded file & bring in the coordinates of any column to be set out. 6. Hold prism pole at tentative position of that column on ground, bisect it & get measured its coordinates. 7. In next reading machine will display the discrepancies in the coordinates of the point & point to be set out. 8. Direct the reflector man accordingly to occupy the new position, bisect him again &	**1** **1** **1** **1**

get measured its coordinates to know the discrepancy. 9. Repeat the process till you get no discrepancy in the coordinates of point occupied & point to be set out. In this way Get marked centres of rest of the columns. 10. Check the accuracy of the process of setting out by comparing the diagonal distance between the extreme column centres to their calculated values.	
d) Describe the temporary adjustment of digital level.	**4**
Temporary adjustment of digital level:- 1) Setup stability:- The digital level should be fixed by rotating its screw head on top of tripod stand. Set tripod legs wide apart to increase the stability of the setup. 2) Centering:- Setup the tripod roughly above the station point .The tripod head plate should be approximately horizontal. Hook the plumb line into the retaining screw and set up the tripod roughly centered above the ground mark. 3) Levelling and fine centering:- Align the control unit parallel the imaginary connecting line between two tribrach screws. Level the instrument in the telescope axis by means of the tribrach screws. 4) Shift the tribrach on the tripod head plate until the plumb line is hanging centrally above the ground mark. Repeat the leveling several times if required. 5) Focus the telescope properly to get clear image of cross hairs .	**1** **1** **1** **1**
e) State the principle of EDM with sketch.	**4**
Principle of EDM:- The fig shows a survey line AB, the length D of which is to be measured using EDM equipment placed at ends A. Let a transmitter be placed at A to propagate electromagnetic waves towards B, and let a receiver B placed at B, along with a timer. If the timer at B starts at instant of transmission of wave from A, and stops at the instant of reception of incoming wave at B, the transit time for the wave from A and B in known.  From this transit time, and from the known velocity of propagation of the wave, the distance D between A and B can be easily computed. However this transit time is of the order of 1 × 10-6 which requires varying advanced electronics. Also it is extremely difficult to start the timer at B when the wave is transmitted at A. Hence a reflector is placed at B instead of a receiver. This reflector reflects the waves back towards A, where they are received as shown in the fig. Thus the equipment at A acts both as a transmitter as well as receiver. The double transit time can be easily measured at A. This will require EDM timing devices with an accuracy of ± 1 × 10-9s.	**1** **2** **1**
f) Draw a neat sketch of simple curve showing all elements.	**4**

Simple curve  ***(Note- 2 marks for sketch and 2 marks for labeling)***	**4***
Q.4 Attempt any <u>FOUR</u> of the following:	**16**
a) How will you locate grade contour on contour map.	**4**
Procedure for establishing grade contour on ground : The grade contour along hill side can be established by following procedure. **1.** Suppose a grade contour of 1 in 30 is to be established on ground. The points of grade contour can be marked approximately using Abney level. **2.** By setting the instrument of tripod do all temporary adjustments. Take the reading on bench mark of R.L. say 100 m as B.S. reading 0.400 m; so that H.I. will be 100.400 m. **3.** Therefore R.L. of first point (40 m away in straight line) will be 100.000 – (40/30) = 98.67 m. And therefore to get this R.L. on ground, the staff reading should be 100.400 – 98.67 = 1.73 m **4.** Now, the staff is held 40 m away from bench mark and up and down movement is done to get 1.73 m reading and then point is marked on ground with peg. **5.** The above procedure is continued in the same straight line and corresponding points are marked on ground. **6.** Finally the line joining all the marked points will give us the required grade contour of 1 in 30 accurately.  	**3** **1**
b) Write four applications of GIS.	**4**
Applications of GIS:- 1) Map making	**4***

2) Site selection
3) Mineral Exploration
4) Land use planning and management
5) Environmental Impact studies
6) Natural Hazard mapping or assessment
7) Water Resources availability.

(Note- 1 mark each for any four)

c) Differentiate between active system and passive system of remote sensing. **4**

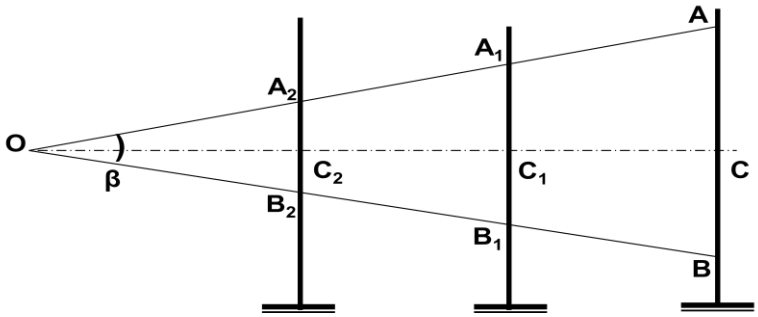
Sr.No.	Active System	Passive System
1)	In this system man made resources of energy are used.	In this system natural sources of are used.
2)	The electromagnetic waves are transmitted and reflected back from ground to record the data.	The natural sunrays are allowed to impact on ground objects and received back from earth surface to collect data.
3)	The active remote sensors like satellite or airborne sensors, micro wave sensors, radar, etc. are useful.	The passive remote sensors like film photography, infrared and radiometers are useful.
4)	It gives more accurate details of ground objects even from higher elevation.	This system may give less accurate outputs because of variation in sunlight.
5)	It is widely applicable in flood, earthquake disaster management and subsoil exploration.	This system is limitedly useful in land use and land cover analysis and small scale mapping.

(Note- 1 mark each for any four) **4***

d) Write principle of stadia method. **4**

Principle of stadia method: **3***

The stadia method is based on the principle that the ratio of the perpendicular to the base is constant in similar isosceles triangles.



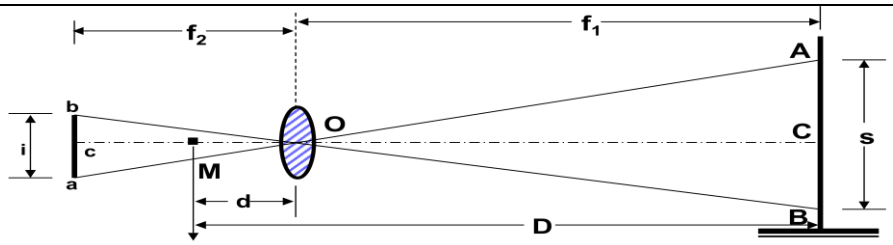
In figure, let two rays OA and OB be equally inclined to central ray OC.
Let A_2B_2, A_1B_1 and AB be the staff intercepts. Evidently,

$$OC_2/A_2B_2 = OC_1/A_1B_1 = OC/AB = \text{constant} = \tfrac{1}{2}\cot\frac{\beta}{2}$$

This constant k entirely depends upon the magnitude of the angle β.

OR

In actual practice, observations may be made with either horizontal line of sight or with inclined line of sight. In the later case the staff may be kept either vertically or normal to the line of sight. **3***



Consider the figure, in which O is the optical centre of the objective of an external focusing telescope.

Let A, C, and B = the points cut by the three lines of sight corresponding to three wires**.**

b, c, and a = top, axial and bottom hairs of the diaphragm.

ab = i = interval b/w the stadia hairs (stadia interval)

AB = s = staff intercept;

f = focal length of the objective

f_1 = horizontal distance of the staff from the optical centre of the objective

f_2 = horizontal distance of the cross-wires from O.

d = distance of the vertical axis of the instrument from O.

D = horizontal distance of the staff from the vertical axis of the instruments.

M = centre of the instrument, corresponding to the vertical axis.

Since the rays BOb and AOa pass through the optical centre, they are straight so that AOB and aOb are similar. Hence, $f_1/f_2 = s/i$

Again, since f_1 and f_2 are conjugate focal distances, we have from lens formula

$$1/f = 1/f_2 + 1/f_1$$

$$\text{i.e.} f_1/f - 1 = f_1/f_2 = s/i$$

$$\text{or } f_1 = f/i\ s + f$$

Horizontal distance between the axis and the staff is $D = f_1 + d$

$$\mathbf{D = (f/i)s + (f+d)}$$

Above equation is known as the distance equation. In order to get the horizontal distance, therefore, the staff intercept s is to be found by subtracting the staff readings corresponding to the top and bottom stadia hairs.

The constant f/i is known as the multiplying constant or stadia interval factor and the constant (f + d) is known as the additive constant of the instrument

.

(Note- Out of 3 marks one mark for figure)

1

e) Write down the procedure for determination of tacheometric constants. **4**

Method of determining tacheometric constants in the field-

3

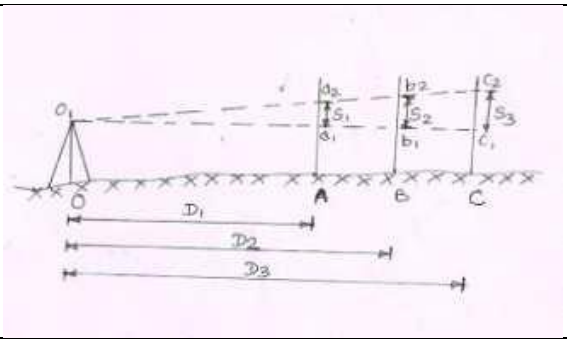
1) A fairly level ground is selected. The tacheometer is set up at O and pegs are fixed at A, B & C, known distances apart.

2) The staff intercepts (stadia hair readings) are noted at each of the pegs. Let these intercepts be S1, S2 & S3.

3) The horizontal distances of the pegs from O are actually measured. Let these distances be D1, D2 & D3.

4) By substituting the values of D1, D2, D3 and S1, S2, S3 in general equation
D = (f/i) S + (f+d)
We get a number of equations, as follows
D1 = (f/i) S1 + (f+d)
D2 = (f/i) S2 + (f+d) and so on.

5) By solving the equations in pairs, find tacheometric constants (f/i) and (f+d)



1

f) State the meaning of degree of curve and long chord. **4**

Degree of curve : The angle subtended at the centre by a standard chord of 30 m length, is known as degree of curve. **2**

Long Chord : The straight line joining rear tangent point and forward tangent point is called as long chord of curve. **2**

Q.5 Attempt any <u>TWO</u> of the following: **16**

a) The following records are obtained in a traverse survey, where the length and bearing of the last line were not recorded. **8**

Line	Length (m)	Bearing
AB	**75.50**	**$30^0$24'**
BC	**180.50**	**$110^0$36'**
CD	**60.25**	**$210^0$30'**
DA	**?**	**?**

Compute the length and bearing of line DA.

Let L=Latitude, D=Departure, l=length and θ = bearing of line DA

Line	Length (m)	Bearing	Reduced bearing(θ)	L=lcosθ	D= lsinθ
AB	75.50	$30^0$24'	N$30^0$24'E	+65.12	+38.21
BC	180.50	$110^0$36'	S$69^0$24'E	-63.51	+168.95
CD	60.25	$210^0$30'	S$30^0$30'W	-51.91	-30.60
DA	?	?		L	D

2

For a closed traverse, ∑L=0

∴+65.12-63.51-51.91+L=0 **1**

∴L= 50.30 (+)

∑D=0

∴+38.21+168.95-30.60+D=0 **1**

∴D= -176.56 (-)

As latitude is +ve and departure is –ve, the line lies in IV quadrant. **1**

Length of line DA = l = $\sqrt{(L)^2 + (D)^2}$ **2**

= $\sqrt{(50.30)^2 + (-176.56)^2}$

l = 183.58 m

Bearing of line DA

$tan\theta = D/L$ = 176.56/50.30 **1**

$\boldsymbol{\theta = 74°5' = N\ 74°5'W}$

b) The co-ordinates of two points P and Q are as follows: — **8**

Point	Co-ordinates	
	N	E
P	982.5	825.2
Q	1198.6	576.4

Find the length and bearing of line PQ.

Latitude of line PQ = L = 1198.6 – 982.5 — **1**
= 216.1 (+)

Departure of line PQ = D = 576.4 – 825.2 — **1**
= -248.8 (-)

As latitude is +ve and departure is –ve, the line lies in IV quadrant. — **1**

Bearing of line PQ

$tan\theta = D/L$ = 248.8/216.1 — **2**

$\boldsymbol{\theta = 49°1'24'' = N\ 49°1'24''\ W}$

WCB of line PQ = $360°0'0'' - 49°1'24''$ — **1**

$\boldsymbol{= 310°58'36''}$

Length of line PQ = l = $\sqrt{(L)^2 + (D)^2}$ — **2**

$= \sqrt{(216.1)^2 + (-248.8)^2}$

l = 329.55 m

c) Calculate the horizontal distance CD and RL of D, when the constants of instrument are 100 and 0.15. — **8**

Inst. Stn.	Staff stn.	Vertical angle	Hair readings (m)	Remarks
C	BM	$-5^0 20'$	1.520, 1.800, 2.450	RL of BM = 750.50 m
C	D	$+8^0 12'$	0.750, 1.500, 2.250	

Given : (f/i) = 100, (f+d) = 0.15

$\theta 1 = 5°20'$ $\quad \theta 2 = 8°12'$

h_1 = 1.800 m, h_2 = 1.500 m

B.M. RL = 750.50 m

Staff intercept at BM = S_1 = 2.45 – 1.52 = 0.93 m — **2**

Staff intercept at D = S_2 = 2.25 – 0.75 = 1.50 m

V_1 at BM = (f/i)S_1 x $(\sin 2\theta 1)/2$ + (f+d)sin $\theta 1$ — **1**

= 100 x 0.93 x $\sin(2x5°20')/2$ + 0.15 x sin5°20'

= 8.620 m

V_2 at D = (f/i)S_2 x $(\sin 2\theta 2)/2$ + (f+d)sin $\theta 2$ — **1**

= 100 x 1.50 x $\sin(2x8°12')/2$ + 0.15 x sin8°12'

= 21.197 m

HI = RL of instrumental axis = RL of BM + h_1 + V_1 — **1**

= 750.500 + 1.800 + 8.620

= 760.920 m

RL of station D = HI + V_2 - h_2 = 760.920 + 21.197 – 1.500 **= 780.617 m** **Horizontal Distance CD** = (f/i)S_2 x $\cos^2 \theta 2$+ (f+d) cos $\theta 2$ = 100 x 1.500 x $\cos^2$ 8°12'+ 0.15 x cos 8°12' **=147.097 m**	**1** **2**
Q.6 Attempt any <u>TWO</u> of the following:	**16**
a) Calculate the ordinates at 25 m interval to set out a circular curve having a long chord of 300 m and versed sine of 10 m.	**8**
Given: L = 300m, interval x = 25m, versed sine = 10m Versed Sine is the offset of the curve at middle of the long chord = O_0 O_0 = R - $\sqrt{R^2 + (\frac{L}{2})^2}$ Where R= Radius of curve, L=Length of long chord 10 = R - $\sqrt{R^2 + (\frac{300}{2})^2}$ **R = 1130 m** The ordinates at distance x from the mid point may be calculated by O_x = $\sqrt{R^2 - (x)^2}$ - (R - O_0) **Ordinates at 25 m interval are:** O_{25} = $\sqrt{1130^2 - (25)^2}$ - (1130 - 10) = 9.70 m O_{50} = $\sqrt{1130^2 - (50)^2}$ - (1130 - 10) = 8.89 m O_{75} = $\sqrt{1130^2 - (75)^2}$ - (1130 - 10) = 7.51 m O_{100} = $\sqrt{1130^2 - (100)^2}$ - (1130 - 10) = 5.56 m O_{125} = $\sqrt{1130^2 - (125)^2}$ - (1130 - 10) = 3.06 m O_{150} = $\sqrt{1130^2 - (150)^2}$ - (1130 - 10) = 0.00 m Hence OK ***(Note- 1 mark each for each ordinate)***	**1** **1** **6***
b) Describe the use of digital theodolite for measurement of horizontal and vertical angle.	**8**
I) Procedure for measurement of horizontal angle with digital theodolite: 1) Taking out digital theodolite for box and fix it on tripod over required station. 2) Approximate leveling by leg adjustment and centering by judgment . 3) Levelling the digital theodolite using foot screws by usual method i.e. plate level parallel to pair of foot screw and perpendicular position 4) Focusing of diaphragm and object using eyepiece and focusing screws, 5) Switch on the digital theodolite. 6) Seleclt the left or right direction mode by press button L/R 7) Direct the telescope towards initial object, bisect it, clamp the theodolite using horizontal clamp screw, make accurate bisection by using slow motion screw. 8) Press the button for zero reading, 9) Unclamp the clamp screw and bisect the final object, clamp it by clamping the clamp	**4**

screw. Accurate bisection by the slow motion screw. 10) Press the hold button, LCD gives required horizontal angle between two point 11) The process may be repeated for required number of times to get mean reading. **b) Procedure for measurement of vertical angle with digital theodolite:** 1) Taking out digital theodolite for box and fix it on tripod over required station. 2) Approximate leveling by leg adjustment and centering by judgment. 3) Levelling the digital theodolite using foot screws by usual method i.e. plate level parallel to pair of foot screw and perpendicular position 4) Focusing of diaphragm and object using eyepiece and focusing screws, 5) Switch on the digital theodolite. 6) Direct the telescope toward A, bisect it. Clamp the instrument, accurate bisection by slow motion screw. 7) Press hold button, LCD gives required vertical angle from zenith point. 8) Similarly bisect and take the reading at B. 9) Difference of two angle gives required vertical angle AOB	**4**
c) (i) What are the additive and multiplying constants of planimeter?	**4**
Area of the irregular figure measured by planimeter is given by: $A = M (FR - IR \pm 10N + C)$ Where M = Multiplying constant C = Additive costant **Multiplying Constant:** It is the multiplier whose value is marked on tracing arm next to the scale division (the number of units of area per revolution of the roller or wheel). It can be obtained by length of tracing arm x circumference of the wheel. Generally it is taken as 100. **Additive Costant:** It is the constant given in the table provided by the manufacturer. It is taken in to consideration only when anchor point is inside the figure, else it is zero.	**2** **2**
(ii) State the possible error while using planimeter for finding area of an irregular figure.	**4**
Possible error while using planimeter for finding area of an irregular figure: **1) Instrumental Error** i) Roller of planimeter which must rotate the axis freely and withot vibrations, if not, then causes error. ii) The plane of the registering roller rim must be perpendicular to the axis of the tracing arm. **2) Manual Error** i) Improper noting of zero, crossing the index point i.e. wrong number of 'N'. ii) Incorrect tracing of the boundary iii) Error in noting initial reading or final reading. iv) Failing to consider the area of the zero circle, in case the anchor point is kept inside the area to be measured. (i.e. value of 'C'.) v) Error in calculation. vi) Error in setting of arm length. vii) Overlapping or repetition in tracing boundary. ***(Note- 1 mark each for any four)***	**4***