SUMMER -2016 EXAMINATION

Subject code: Advanced Surveying

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 :	**12M**
i) Define the term interpolation of contours.	
Interpolation of contours is the process of locating the required contours proportionately between the plotted reduced levels on sheet.	**2M**
ii) Define zero circle.	
For a mechanical or polar planimeter, when the tracing point moves along a circle without rotation of the wheel i.e. when the wheel just slides without any change in reading, the circle is known as the zero circle.	**2M**
iii) State Bowditch's Rule.	
Bowditch's Rule states that the total error in latitude or departure is distributed in proportion to the lengths of the traverse. Correction in latitude or = $\frac{\text{length of the side}}{\text{perimeter of the traverse}}$ x total error latitude or departure. departure of any side	**2M**
iv) Define transiting.	
Transiting is the method of turning the telescope about its horizontal axis in vertical plane through 180^{O}.	**2M**

v) State the constants of tacheometer.	
The quantities $\left(\frac{f}{i}\right)$ and $(f+c)$ are known as constants of tacheometry. $\left(\frac{f}{i}\right)$ = Multiplying constant $(f+c)$ = Additive constant where, f = focal length of object glass i = length of image c = distance between optical centre and vertical axis of instrument.	**2M**
vi) Enlist the uses of total station in surveying.	
The uses of total station are : 1) To measure horizontal, vertical and slope distances. 2) To measure horizontal and vertical angles. 3) To measure the level difference between points. 4) To carry out contouring. 5) To prepare the map and drawings using software. 6) To prepare layout of building. 7) For speedy completion of any type of project work.	***½ mark each any four***
vii) Define compound curve and reverse curve.	
Compound Curve : Compound curve consist of series of two and more simple curves of different radii in same direction and the centers of two adjacent curve lie on the same side. Reverse Curve : Reverse curve consist of two arc bending in opposite directions, their centers lie on opposites sides of the curve and they have one common tangent	**1M** **1M**
viii) Enlist the type of curves in road and railway alignment.	
The type curves in road and railway alignment : 1) **Horizontal Curves** a) Simple curve b) Compound curve c) Reverse curve d) Transition curve 2) **Vertical Curves** a) Summit curve b) Valley curve	**1M** **1M**
Q.1. b) Attempt ANY TWO of the following :	**8M**
i) Describe the method of locating contours by square method.	
1) The method of square is indirect method of locating contours. 2) The method of squares is used where the area to be surveyed is small and not much undulating. 3) The area to be surveyed is divided into squares of size varying 5m to 20m. The size of the square depends upon the nature of ground. 4) The reduced level of the corners of squares (called nodal points) is determined by levelling. 5) The squares are plotted with suitable scale and the calculated reduced levels of these nodal points are written on the respective corners. 6) The contours are then interpolated between them.	**3M**

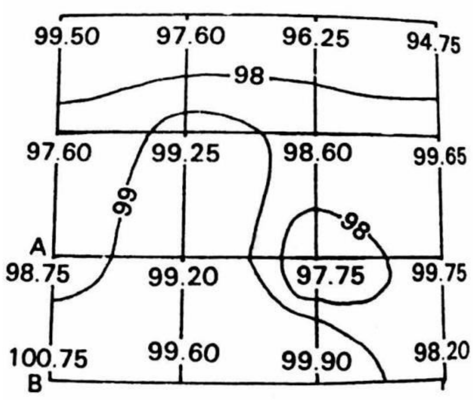


FIG- Square Method of Contouring

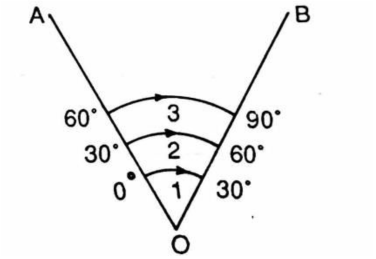
1M

ii) State the procedure of measurement of horizontal angle by repetition method.

The horizontal angle is measured very precisely using method of repetition as follows :

1) Set-up the theodolite over station O and level it properly.
2) Set the vernier A and vernier B at 0°0'0" and 180°0'0" respectively on the horizontal graduated scale. This is done by loosening the upper clamp and moving the upper plate until the zero of the vernier plate A coincides with the zero of the main scale. Tighten both the clamps.
3) Loosen the lower clamp and bisect point A, the readings in vernier A and vernier B should be 0°0'0" and 180°0'0" respectively. Minor adjustment in reading is done by lower tangent screw.
4) Loosen the upper clamp and bisect point B. Point B is accurately bisected using upper tangent screw. Tighten both the clamps and note the readings in both verniers.
5) Tighten the upper clamp and rotate the telescope either in clockwise or anticlockwise until it bisects point A. The readings in the vernier should remain the same. Loosen the upper clamp and bisect point B. Point B is accurately bisected using upper tangent screw. Tighten both the clamps and note the readings in both verniers. This time vernier A will be twice of the earlier angle.
6) In the same way take the angle for the third time.
7) Read the final angle. The average angle by face left will be the accumulated angle divided by 3.
8) Change the face of the theodolite and repeat the same procedure.
9) The mean of both angles gives the horizontal angle AOB.

3M for proce.



1M for sketch

iii) State the practical applications of remote sensing in civil engineering project.

The practical applications of remote sensing in civil engineering project are :

1) Applications of Remote sensing with respect to natural hazard : In case of flood , earthquake ,volcano eruption and related hazards , land slides, Tsunami, cyclone, etc.

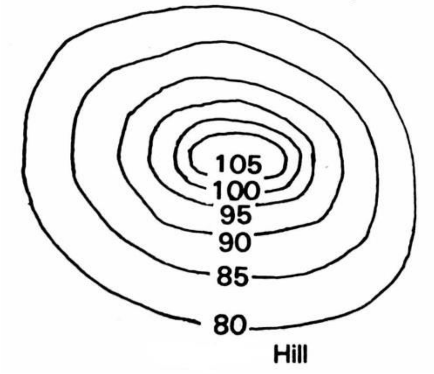
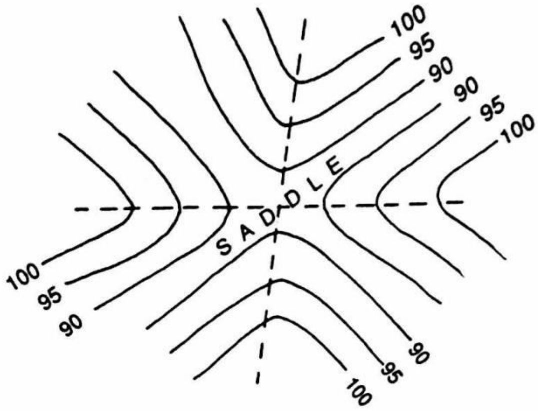
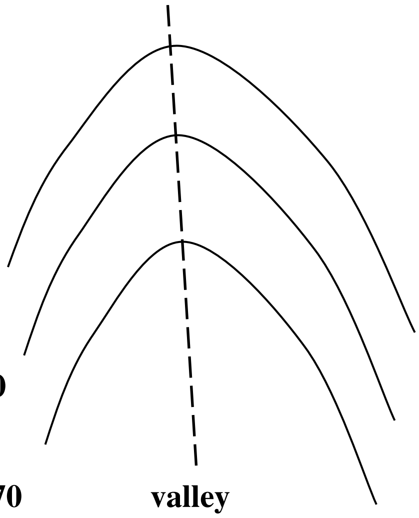
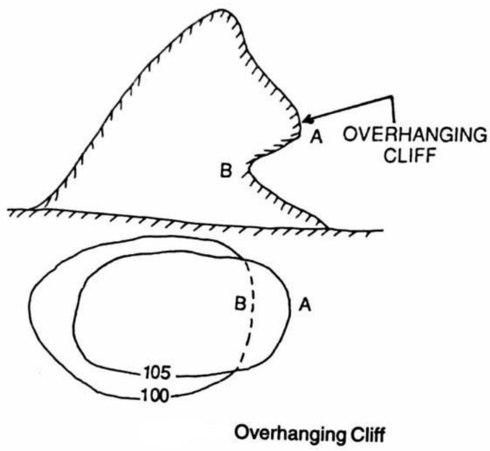
2) Environmental application :

i. INSAT series of satellite used for weather forecast i.e. cyclone, cloud, wind velocity, sea states, pollution, global warming, and ozone layer depletion.

ii. Mineral exploration : Detailed exploration of non –renewable resource like minerals and fossil fuels, geological data, location of minerals, mapping of mineral zones.

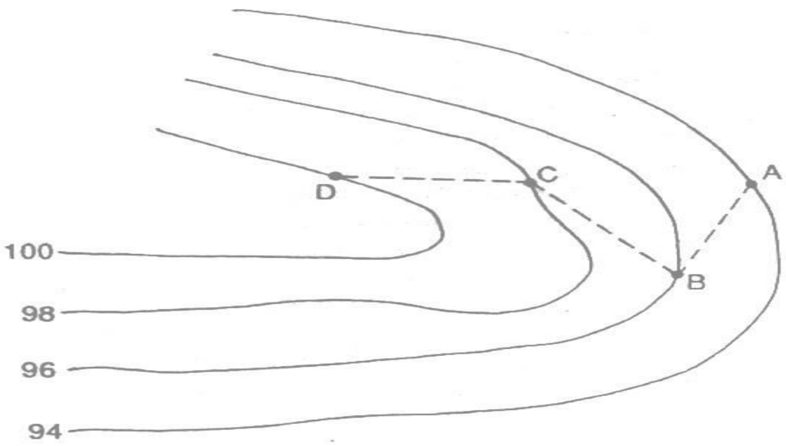
1M each any four

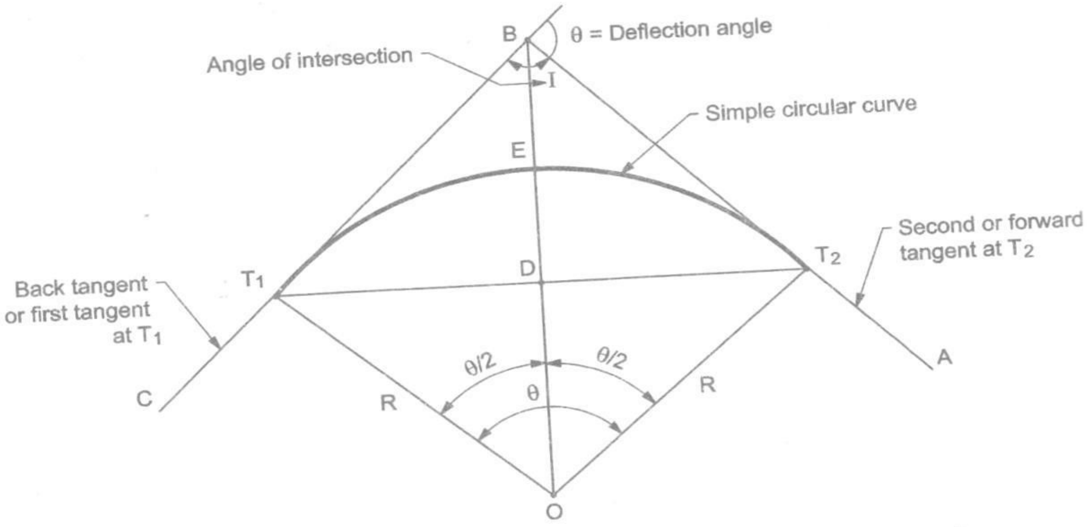
3) Land use and land cover Analysis : Land use for Urban purpose agricultural sea forest etc. particular cropping pattern, spread area. **4) Archaeology** : To recognize archaeological patterns of prehistoric land use, buried archaeologically important sites. **5) Revision of topo sheets** : Rapid revision 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 tunnel. **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 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.	
Q. 2. Attempt ANY FOUR of the following :	**16**
a) State any four uses of contour.	
By studying a contour map : 1) The nature of the ground surface or topography of a country whether hilly, undulating or flat can be understood. 2) Possible routes of communication between two different places can be known. 3) The capacity of a reservoir or the area of catchment can be determined approximately. 4) The visibility of points can be established. 5) A suitable route for a given gradient can be marked on the map. 6) The suitable site for most economical alignment can be selected for any engineering projects like dams, canals, roads, sewers, railways, etc. 7) A section of the ground surface can be drawn any direction from the contour map. 8) Quantities of earthwork can be determined approximately.	**1 M each any four**

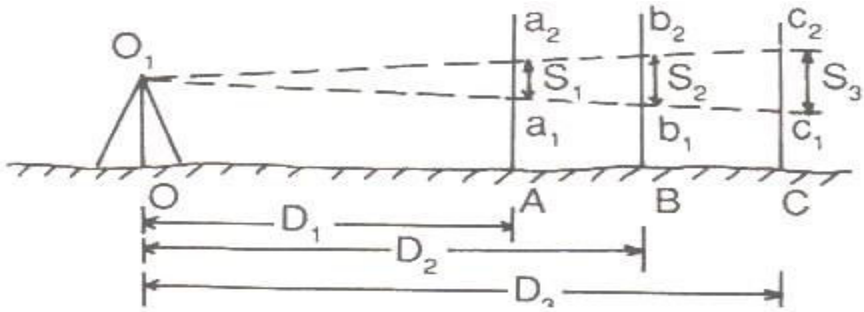
b) Draw contours for following features: **i) Hill ii) Saddle iii) Valley iv) Overhanging Cliff**	
  90 80 70 **valley**  	**1M each**
c) Give the desired relationship between fundamental axes of transit theodolite.	
The desired relationships between fundamental axes of transit theodolite when in perfect adjustment are : 1) The axis of plate level must be perpendicular to the vertical axis. 2) The line of collimation must coincide with optical axis of telescope and should be perpendicular to the horizontal axis. 3) The horizontal axis must be perpendicular to the vertical axis. 4) The axis of telescope (axis of bubble tube) must be parallel to the line of collimation. 5) If the instrument has fixed vernier for vertical circle, it must read zero in levelled position.	**1M each any four**
d) Explain temporary adjustment required for theodolite.	
The temporary adjustments have to be carried out at every set-up of instrument before taking observations with the theodolite. **1) Setting up the theodolite:** Setting up of the theodolite includes: **a) Centering it over the station:** Procedure: 1) Place the tripod over the stations by spreading its legs at a convenient height. 2) Suspend the plumb bob over the station and bring it exactly over the station point by moving it radially as well as circumferentially, then press the legs firmly into the ground.	**1M**

3) By this the instrument is approximately levelled also. **b) Levelling up:** Accurate levelling is done with reference to the plate level by means of footscrews. The object of levelling is to make the vertical axis truly vertical. Procedure: 1) Turn the theodolite until the plate bubble is parallel to any one of the pair of footscrews. 2) Turn the theodolite about its centre of its run by turning both, foots crews uniformly. By thumb and forefingers either moves it towards each other or away from each other. 3) Turn the theodolite until the bubble is perpendicular to the previous position. Now, move the third footscrew until the bubble is brought to the centre of the run. 4) Repeat the process for the other two pairs. 5) Now rotate the theodolite about the vertical axis through 360°. The bubble will remain central provided it is in correct adjustment. The vertical axis is made thus truly vertical. **2) Focussing the eye piece :** Focussing the eye-piece makes the cross hairs on the diaphragm distinct and clear. To do this, direct the telescope towards the sky or hold a sheet of white paper in front of the object glass and move the eye piece circumferentially or in or out until the cross-hairs are seen sharp and black. **3) Focussing the object glass :** Focussing the object glass is to bring the image of the object formed by the object glass exactly in the plane of the cross hair. If not accurately done there is a apparent movement of the image when the observer moves up and down. This is affect of parallax. This can be removed with sharp focusing.	**1M** **1M** **1M**
e) State the errors eliminated by repetition method.	
The errors eliminated by repetition method are : 1) Errors due to eccentricity of verniers and centers are eliminated by taking the both vernier readings and averaging them. 2) Errors due to in adjustments of line of collimation and trunnion axis are eliminated by taking both face left and face right readings. 3) Errors due to inaccurate graduations are eliminated by taking the readings at different parts of circle. 4) Errors due to inaccurate bisection of object may compensate each other. 5) Errors due to improper levelling can be minimized	**1M each any four**
f) What are the checks applied in case of closed traverse?	
The errors involved in traverse are of two types: angular and linear. For important traverse angular values are checked by doubling the angles and linear measurements by chain and tape. **Check For Angular Measurements:** **a) Traverse by included angles** i) The sum of measured included angles should be (2n - 4) x 90° ii) The sum of measured exterior angles should be (2n + 4) x 90° where n is number of sides.	**2M**

b) Traverse by deflection angles The sum of measured deflection angles should be 360° considering the left deflection angles as negative (- ve) and right deflection angles as positive (+ ve). **c) Traverse by observation of bearings** The fore bearing of the last line should be equal to ±180°.	**1M** **1M**
Q.3 Attempt Any <u>FOUR</u> of the following	**16**
a) State the application of total station.	
Application of Total Station:- 1) Measurement of slope distance. 2) Measurement of horizontal distance. 3) Measurement of vertical distance. 4) Measurement of horizontal angle. 5) Measurement of vertical angle. 6) Measurement with distance stake out. 7) Measurement of volume and area. 8) Leveling function. 9) Remote distance Measurement. 10) Measurement of co-ordinates. 11) Offset point measurement. 11) Lot staking. 12) Traverse measurement. 13) 3-D cross section measurement. 14) Remote elevation measurement function. 15) Rear section measurement. 16) Offset station measurement. 17) Co-ordinate area measurement. 18) Scaling measurement function.	***1 mark each any four***
b) State components of one second micro-optic theodolite.	**04**
Component parts of micro optic theodolite 1) Telescope 2) Magnification with standard eyepiece. 3) Level tube 4) Foot screws. 5) Tribatch & Trivet 6) Optical micrometer 7) Microscope with focusing knob 8) Horizontal circle 9) Vertical circle. 10) Optical Plummet 11) Tri-batch with foot screws 12) Plate level 13) Collimation slow motion screw 14) Horizontal clamp	***1/2 mark each any eight***
c) What is meant by grade contour? How it will be located in field?	
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 termed as grade contour. **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 and B.S. reading 0.400 m; so that H.I. will be 100.400 m.	**1M**

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 starting point 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.	**2M**
 ***Note- If other data is assumed in explanation it could be considered.***	**1M**
d) State the classification of electronic distance meter.	
Classification of electronic distance meter **A) Classification based on the type of carrier wave used** • Instrument using visible light waves • Instrument using invisible infra-red waves • Instrument using micro waves • Instrument using long ratio waves	**1M**
B) Classification based on range of the instrument. • Short range Instrument • Medium range Instrument • long range Instrument	**1M**
C) Classification based on the Appearance of the instrument • mount type • built in type or total station	**1M**
D) Classification based upon reflected or transmitted wave. • **Reflecting type such as geodimeters** • **Transmitting types such as tellurometer**	**1M**

e) Draw a neat sketch of simple circular curve showing all elements.	
 **Where:** **AB and BC are two tangents** **BT_1 and BT_2 are lengths of tangents** **BE are Apex distance.** **DE are Versed sine** **R is Radius of curve.** **T_1DT_2 are length of long chord** ***(Note- 2 mark for* sketch and *2 mark for labeling)***	***04**
f) State any four application of digital theodolite.	
Application of digital theodolite:- 1. To measure horizontal angle very precisely up to one second. 2. To measure vertical angle accurately up to one second. 3. To set out control points of the particular field. 4. To take reduced levels of ridge and valley lines accurately. 5. To determine horizontal distance more precisely.	***1M mark each any four***
Q.4 Attempt Any FOUR of the following	**16M**
a) Explain principle of tachometry survey.	
Principle of tachometry is based on principle of similar triangle in which corresponding sides & altitudes are proportional. The ratio of distance of base from apex and length of base is always Constant.	**1M**



In fig. $O_1a_1a_2$, $O_1b_1b_2$, $O_1c_1c_2$ are all isosceles triangles where D_1 , D_2, D_3 are the distances of bases from the apices and S_1, S_2, S_3 are the Lengths of the bases. According to stated principle. $D_1/ S_1 = D_2/ S_2 = D_3 / S_3$ = Constant f/i= Multiplying constant. f= Focal length of objective. i= Stadia Intercept.	**1M** **2M**
b) State the uses of Global positioning system (GPS)	
Uses of Global positioning system 1. To prepare contour maps. 2. To prepare longitudinal section of roads. 3. To prepare alignment of roads & bridges. 4. Used for navigation purpose. 5. For Surveying work. 6. Used for Mapping. 7. Used for Remote sensing. 8. Used in Geographical information system. 9. Used in Military and Space 10. For Agriculture.	***1 mark each any four***
c) The following particulars were noted while measuring the area of a figure with planimeter. **(i) IR and FR were 8.652 and 6.798 respectively.** **(ii) M=100 cm^2 and C=20** **(iii) The zero of dial passed the index once in anticlockwise direction.** **(iv) Scale of map is 1 cm = 10 cm.** **(v) Anchor point was inside the figure; calculate the area of the figure.**	

Given : I.R. = 8.652, F.R. = 6.798, N = - 1, M = 100 sq.cm., C = 20 Scale of Map 1cm=10 cm. **Find:** Area of figure. **Solution :** By formula, A = Mx (F.R. – I.R. ± 10N + C) A = 100x (6.798– 8.652 - 10 x 1 +20) A = 100x (8.146) A =814.6 sq.cm. Scale of map 1 cm = 10 cm Actual area A = 814.6 x 10 x 10 A = 81460 sq.cm.	**1M** **1M** **1M** **1M**
d) State the advantages and limitation of remote sensing.	
Advantages of remote sensing: 1. Relatively cheap and rapid method of acquiring up-to-date information over a large geographical area. 2. It is the only practical way to obtain data from inaccessible regions. 3. At small scales, regional phenomena which are invisible from the ground are clearly visible. 4. Cheap and rapid method of constructing base maps in the absence of detailed land surveys. 5. Easy to manipulate with the computer and combine with other geographic cover ages in the GIS. 6. It is the only way to obtain unbiased data with repetitive coverage. **Limitations of remote sensing :** 1. Too costly to build and operate. 2. Needs sound knowledge and understanding of how the instrument is making the measurements. 3. Also requires knowledge of phenomena you are sampling. 4. Thus one can say that data interpretation is difficult.	***2 M for any two*** ***2 M for any two***
e) List any four essential characters of Tacheometer.	
1. The value of constant f/i = 100 Where, f = focal length i = length of image. 2. The telescope should be powerful, the magnification should be 20 to 30 times the diameter	***1 M for each any four***

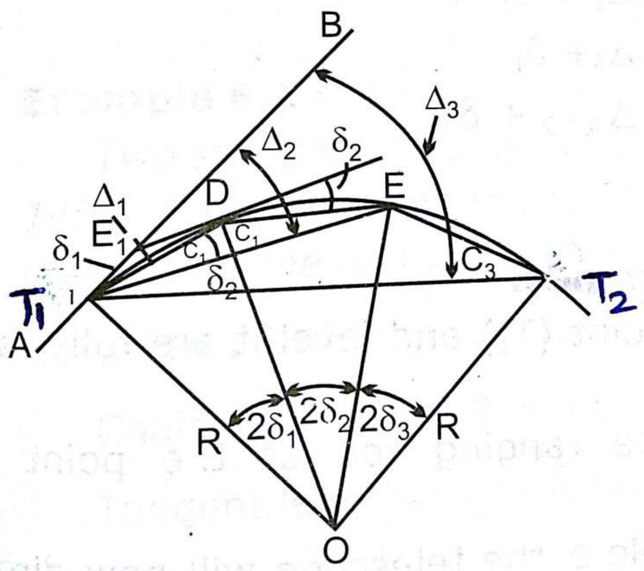
3. The telescope should be fitted with anallatic lens to have the value of f +c = 0

4. The vision through the telescope should give a clear and bright image at a long distance.

5. The aperture of the objective should be 35 to 45mm in diameter in order to have a sufficiently bright image.

f) Explain the setting of curve by Rankine's deflection angle method.

Rankine's deflection angle Method:-



1M for fig

1) Set up theodolite at first tangent point, T_1 and level it carefully, set the vernier A to 360^0
2) bisect the ranging rod at the point of intersection B.
3) Set the vernier to A to the first deflection angle Δ_1, the telescope will now direct along T_1D.
4) Pin down the zero end of the chain or tape at T_1 holding arrow on the chain at a distance equal to the length of first sub chord swing the chain around T_1 and bisect the arrow by the diaphragm hairs to fix the position on first point, D on the curve.
5) Loosen the upper plate and set the vernier to the second deflection angle Δ_2 the line of sight will view direct along T_1E.
6) Pin down the zero end of the chain or tape at D and swing the other end. Bisect the arrow held at the other end, the second point on the chain E is thus located.
7) Thus establish points on the curve until the end of the curve is reached. The last point located must coincide with the tangent point T_2 already located. The slight difference can be adjusted on the last few pegs.
8) If the error is beyond the permissible limits the whole work must be checked or repeated.

3M for proce.

9) In case of the left hand curve, each of the calculated values of the deflection angle (Δ_1, Δ_2 etc) should be sub subtracted from 360^0. The angle thus obtained will be set on the vernier of the theodolite for setting out the curve.	
Q.5 Attempt Any TWO of the following	**16M**

a) Following are the observations taken while running closed traverse by theodolite. Find co-ordinates points using Bowditch rule.

Line	Length in (m)	Bearing
AB	**335**	**180°20'**
BC	**850**	**90°20'**
CD	**408**	**357°**
DA	**828**	**265°**

Solution:

Line	Length in (m)	Bearing	R.B.	Consecutive co-ordinates		Correction		Corrected consecutive co-ordinates	
				Lat.	Dep.	Lat.	Dep.	Lat.	Dep.
AB	335	180°20'	S0°20'W	-334.99	-1.94	0.64	-0.26	-334.35	-2.20
BC	850	90°20'	S89°40'E	-4.94	849.98	1.63	-0.65	-3.31	849.33
CD	408	357°	N3°W	407.44	-21.35	0.78	-0.31	408.22	-21.66
DA	828	265°	S85° W	-72.16	-824.84	1.60	-0.63	-70.56	-825.47

***8**

Calculation of reduced bearings:
Line AB, RB= $180^o20'-180 = S0^o20'W$
Line BC, RB=$180- 90^o20' = S89^o40'E$
Line CD, RB=$360- 357^o = N3^oW$
Line DA, RB=$265- 180= S85^oW$

Calculation of Latitudes:
Latitude = $L\cos\theta$
Line AB = $335 \times \cos(0^o20') = -334.99$
Line BC = $850 \times \cos(89^o40') = - 4.94$
Line CD = $408 \times \cos(3^o) = 407.44$
Line DA = $828 \times \cos(85^o) = -72.16$

Error in sum of latitudes = -4.65

Correction will have +ve sign

Calculation of Departures:
departure = $L\sin\theta$
Line AB= $335 \times \sin(0^o20') = - 1.94$
Line BC = $850 \times \sin(89^o40') = 849.98$
Line CD = $408 \times \sin(3^o) = - 21.35$
Line DA= $828 \times \sin(85^o) = -824.84$

Error in sum of departures = 1.85
Correction will have -ve sign
Bowditch's Rule:
Correction to latitude or departure of any side =Total error in latitude or departure x $\frac{Length\ of\ that\ side}{Perimeter\ of\ traverse}$

Perimeter of traverse = 335 + 850 + 408 + 828 =2421 m

Corrections to latitudes:
Line AB = 4.65x335/2421 = 0.64
Line BC = 4.65x 850/2421 = 1.63
Line CD = 4.65x408/2421 = 0.78
Line DA = 4.65x 828/2421 = 1.60

Corrected latitudes:
Line AB= - 334.99+0.64 = -334.35
Line BC= - 4.94+1.63 = -3.31
Line CD= 407.44+0.78 = 408.22
Line DA= - 72.16+1.60 = -70.56

Corrections to departure:
Line AB = 1.85 x335/2421 = - 0.26
Line BC = 1.85x 850/2421 = - 0.65
Line CD = 1.85x408/2421 = - 0.31
Line DA = 1.85x 828/2421 = - 0.63

Corrected departures:
Line AB= -1.94- 0.26 = -2.20
Line BC=849.98 -0.65 = 849.33
Line CD = -21.35-0.31 = -21.66
Line DA = -824.84-0.63 = -825.47

Note- * ***Calculation of RB, latitude, departure, Bowditch rule, correction to latitude , correction to departure, Corrected latitude and corrected departure 1 mark each***

5b) Following are lengths and bearings of closed traverse ABCDA

Line	Length in (m)	Bearing
AB	**260**	**341°**
BC	**240**	**295°**
CD	**250**	**147°**
DA	**?**	**?**

Determine length and bearing of line DA

Solution:

Line	Length in (m)	Bearing	RB	Latitude	Departure
AB	260	341°	N19° W	245.83	- 84.64
BC	240	295°	N65° W	101.42	-217.51
CD	250	147°	S33° E	-209.66	136.15
DA	?	?	?	L	D

Calculation of RB: **1M**
Line AB = 360-341 = N 19° W
Line BC = 360-295 = N 65° W
Line CD = 180-147 = S 19° E
Calculation of Latitudes: **1M**
Latitude = Lcosθ
Line AB = 260 x cos(19°) = 245.83
Line BC = 240 x cos(65°) = 101.42
Line CD = 250 x cos(33°) = -209.66
Let latitude of line DA=L
Algebraic sum of all latitudes in closed traverse is zero.
Therefore, 245.83+101.42-209.66+L=0 **1M**
L= -137.59
Calculation of Departure: **1M**
Departure = Lsinθ
Line AB = 260 x sin(19°) = -84.64
Line BC = 240 x sin(65°) = -217.51
Line CD = 250 x sin(33°) = 136.15
Let Departure of line DA=D

Algebraic sum of all departures in closed traverse is zero. **1M**
Therefore, -84.64-217.51+136.15+D=0
D=166 **1M**

$\Theta= \tan^{-1}\left(\frac{D}{L}\right) = \tan^{-1}\left(\frac{166}{137.59}\right) = 50^o 20' 46.24''$ **1M**

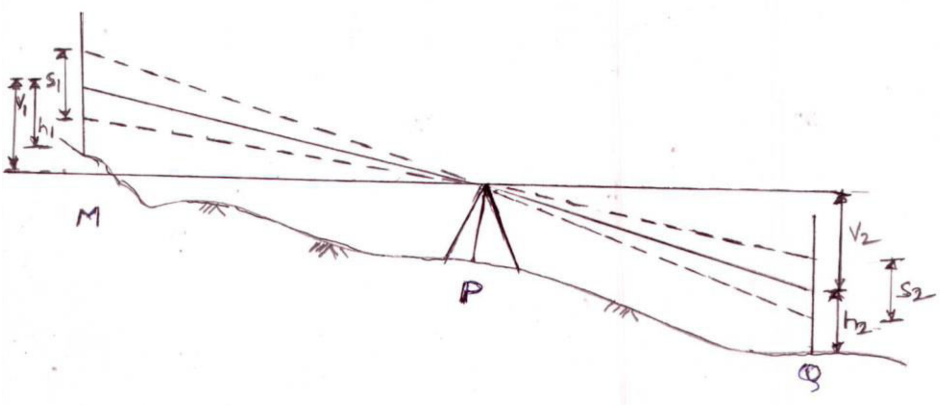
Since latitude is negative and departure is positive, line DA is in SE quadrant.
Therefore, RB= S $50^o 20' 46.24''$ E
WCB=180-RB= $129^o 39' 13.76''$ **1M**
Length of line DA= $\sqrt{L^2 + D^2} = \sqrt{(-137.59)^2 + (166)^2} = 215.60$ m

5c) A tacheometer fitted with anallatic lens and multiplying constant equal to 100 was used and following were observed on a staff held vertical.

Inst. station	H.I.	Staff at	Vertical angle	Stadia reading
P	**1.30**	**M**	**+2°30'**	**1.2, 1.4,1.6**
P	**1.30**	**Q**	**-3°30'**	**1.70, 1.95, 2.20**

RL of station M=100. Calculate RL of P and Q and distance of PQ.

Solution:



Here f/i =100 and f+d = 0 since anallatic lens.

Staff at M:

S_1=1.6-1.2=0.4m
h_1=1.4 and $\theta_1 = 2^o 30'$
$v_1 = f/i \times S_1 \times \frac{\sin(2\theta 1)}{2} + (f+d) \sin \Theta_1$ **1M**
$= 100 \times 0.4 \times \sin(2 \times 2^o 30')/2 + 0$
=1.743m
RL of instrument axis=RL of M $+h_1 - v_1$ = 100 +1.4-1.743 =99.657m **1M**
RL of P = RL of instrument axis – H.I.=99.657-1.30= 98.357m

Staff at Q:

S_2=2.20-1.70 =0.5, h_2 = 1.95 and $\Theta_2 = 3^o 30'$
$V_2 = f/i \times S2 \times \frac{\sin(2\theta 2)}{2} + (f+d) \sin \Theta_2$ **1M**
$= 100 \times 0.5 \times \sin(2 \times 3^o 30')/2 + 0$ **1M**
=3.046m
RL of Q =RL of instrument axis - h_2 - V_2 **1M**
= 99.657-1.95-3.046 =94.661 m **1M**
Dist $D_2 = f/i \times S_2 \cos^2 \Theta_2 + (f+d) \cos \Theta_2$ **1M**
$= 100 \times 0.5 \cos^2(3^o 30') + 0$ **1M**
= 49.813m

Q.6 Attempt Any TWO of the following	16M
a) Find the quantity of water from the contour map of a reservoir, the following contour areas were recorded by planimeter ;the top water level is 200m and lowest point in the reservoir is 180m.	

Contour(m)	200	195	190	185	180	175
Area in m^2	3850	3450	2600	800	450	200

Solution:

Ignoring the statement "lowest point in the reservoir is 180m", and assuming lowest point in the reservoir as given in the table as 175m,

Here , A_1 =3850 , A_2 =3450, A_3= 2600, A_3= 800 , A_5=450, A_6 = 200 m^2 and contour interval D=5m **2M**

By Trapezoidal formula: **3M**

$V = D \times (\frac{A1+A6}{2} + A_2 + A_3 + A_4 + A_5)$

$V = 5(\frac{3850+200}{2} + 3450 + 2600 + 800 + 450)$ **2M**

$= 46625\ m^3$ **1M**

OR

By using Prismoidal Formula:

Volume is calculated considering first five contours / sections since **Prismoidal formula is applicable for odd number of sections** and last contour / section is dealt separately **2M**

$V = \frac{D}{3}(A_1 + 4A_2 + 2A_3 + 4A_4 + A_5) + \frac{D}{2}(A_5 + A_6)$ **3M**

$= 5/3(3850 + 4\times3450 + 2 \times 2600 + 4 \times 800 + 450) + 5/2(450 + 200)$ **2M**

$= 45791.66\ m^3$ **1M**

Note: If the students have calculated volume considering the statement "lowest point in the reservoir is 180m", and ignoring last contour marks may be given.

b) Calculate the ordinates of 25m interval to set out a circular curve having a long chord 300 m and versed sine of 10 m.

Solution:

Versed sine is the offset at the middle of long chord.

Therefore $O_0 = R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$ where R= radius of curve and L= long chord=300 m **2M**

$10 = R - \sqrt{R^2 - (\frac{300}{2})^2}$

Solving for R, R=1130 m **2M**

Ordinates at a distance x from centre of long chord are calculated by formula,

$O_x = \sqrt{R^2 - x^2} - (R - O_0)$ **1M**

$O_{25} = \sqrt{1130^2 - 25^2} - (1130 - 10) = 9.7$ 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

$O_{150} = \sqrt{1130^2 - 150^2} - (1130 - 10) = 0.0$ m **3M**

c) State the procedure of traversing by using total station.	
Solution: The procedure is as follows. **A) CENTERING THE TOTAL STATION**: The instrument must be vertically above the survey station to ensure that horizontal angle observations are correct. The steps are as follows: i) Start with a instrument to get it approximately right above the survey station. ii) Move the foot of tripod so that the optical plummet cross hairs are on to the survey station. iii) Roughly level the instrument using the legs of the tripod the total station should stay almost on target.	**2M**
B) LEVELLING THE TOTAL STATION i) Turn bubble parallel to two foot screws, to bring the horizontal bubble to the centre of its run by moving the foot screws in opposite directions (the bubble moves in the direction of your left thumb). ii) Turn the instrument through 90º and bring the bubble to the centre of its run by adjusting the third foot screw only. iii)Turn the instrument through a further 90º to check the adjustment of the plate bubble. iv) If the bubble remains in centre, then it is in adjusted position . v) If not, move it back one-half of the movement from the centre and re-adjust for a further 90º turn. vi) Repeat the whole procedure; assuming this is the correct, the bubble will stay in a stationary position. vii) The bubble must remain in the same place in the tube during a 360º rotation of the instrument. viii) If the stationary position of the bubble is still off the centre, then a permanent adjustment should be made.	**3M**
C) TRAVERSE FIELD WORK Traversing is carried out with three(3) tripod, one(1)tripod is for the instrument and the other two(2) are for the back and front stations. A minimum of three people are required in a traversing team. The leader of the team performs setting up and reads the instrument, while the 2nd person has the important job of recording the readings on the booking sheet. The 3rd person has the task of moving and setting up the prism as the traverse progresses. There are several steps which should be followed that will lead to a smooth traverse. i) Traverse stations are established at the proposed site (say) (peg 1, peg 2, peg 3 & peg 4 etc). ii) The total station is plumbed over peg 1 and accurately levelled. Prisms are plumbed over peg 2 & 4. iii) Take bearing of first line by bisecting prism at peg 2. iv) Sight the prism at peg 4.Measure the distance between peg 4 and peg 1. Set the instrument to zero. Rotate the instrument and bisect prism at peg 2.Vertical and horizontal angles are displayed in relation to peg 4. The reading is taken and entered in the field book. Distance between peg 1 and 2 also measured with the same technique. v) Record face left horizontal angle reading . vi) Transit the instrument to change to the face right setting. vii) Record face right horizontal angle by same procedure. viii) The total station is moved to peg 2. Prisms are plumbed over peg 1 and 3. Horizontal distances and angles are measured and recorded similarly.	**3M**

<u>**Note:**</u> **If students have written FOLLOWING procedure marks may be given.** Modern total stations have traversing menu. Using that menu procedure consist of setting station point set up and inputting X,Y,Z and H.I values, bisecting back station and other stations. Measure command is given at each bisection. When instrument is shifted to new station , new station set up is chosen and instrument is properly oriented by choosing one of the already surveyed station as back sight and bisecting it.	