MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous)

(ISO/IEC - 27001 - 2005 Certified)

Model Answer: Summer 2019

Subject: Advanced Surveying

(Pages: Total 15)

Sub Code: 17419

Important Instructions to examiners:

1) The answers should be examined by key words 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 errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.)

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

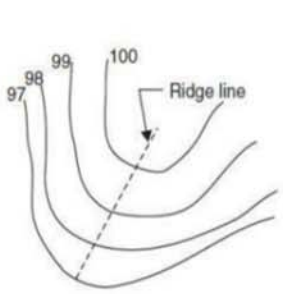
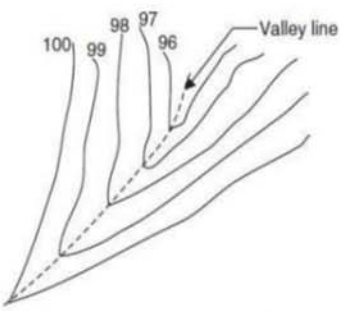
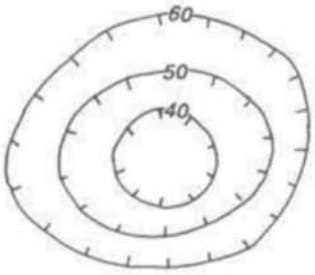
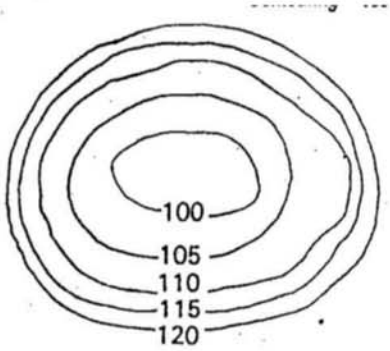
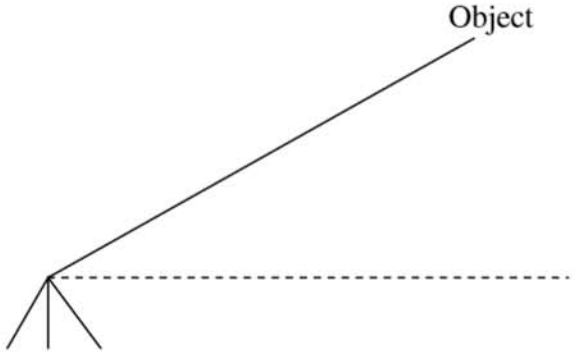
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.

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

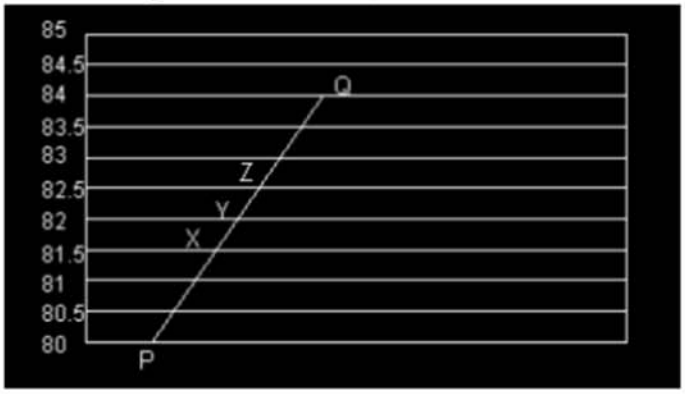
7) For programming language papers, credit may be given to any other program based on equivalent concept

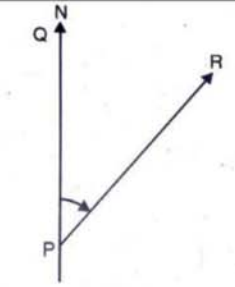
Q. No.	Sub Q. No.	Answer	Marking Scheme
Q.1. a)		**Attempt ANY SIX of the following**	**12M**
	i)	**Define** 1) **Contour interval:** 2) **Horizontal equivalent**	**2M**
	Ans	1) **Contour interval: -** The vertical distance between two successive contours is called "Contour Interval". 2) **Horizontal equivalent: -** The horizontal distance between any two successive contours is called "Horizontal Equivalent".	**1M each**
	ii)	**State any two uses of contour map.**	**2M**
	Ans	1) The nature of the ground surface or topography of a country whether hilly, undulating orflat 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 engineeringprojects like dams, canals, roads, sewers, railways, etc. 7) A section of the ground surface can be drawn in any direction from the contour map.	**1M each (any two)**

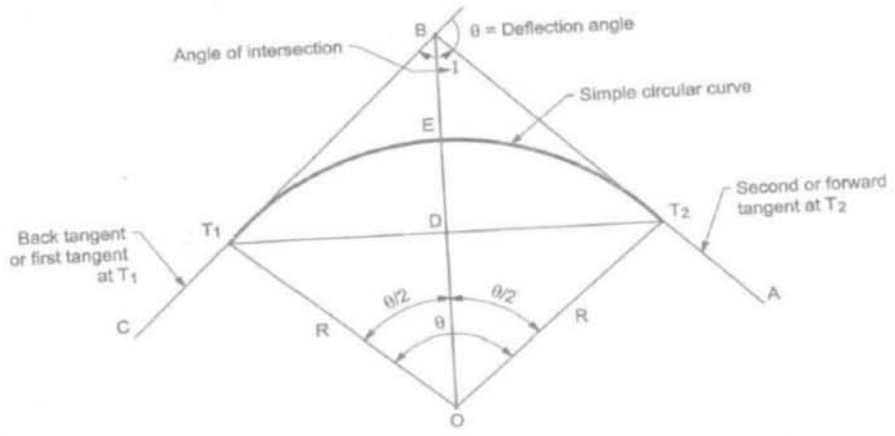
		8) Quantities of earthwork can be determined approximately.	
	iii)	**Define zero circle .**	**2M**
	Ans	For a mechanical or polar planimeter, when the tracing point moves along a circle without rotation of the wheel i.e. when the wheel just slides without any change in reading, the circle is known as the zero circles.	**2M**
	iv)	**Define swinging and transiting.**	**2M**
	Ans	**Swinging:** It is the process of turning the telescope in horizontal plane. **Transiting:** It is the process of turning the telescope through 180° in a vertical plane about its horizontal axis.	**1M each**
	v)	**Define axis of telescope and horizontal axis.**	**2M**
	Ans	**Axis of telescope:-**It is the line joining the centre of eye piece to the optical centre of object glass. **Horizontal axis**: - The axis about which telescope can be rotated in vertical plane.	**1M each**
	vi)	**State any two situations where tachometry is used.**	**2M**
	Ans	1) When obstacles such as steep and broken ground, stretches of water or swamps. 2) In rough country both horizontal and vertical measurements are tedious. 3) In locating contours and filling in detail in a topographic survey.	**1M each (for any two)**
	vii)	**State any two features of digital level.**	**2M**
	Ans	1) It has minimum display resolution of 0.1 mm. 2) It can obtain elevation and distance digitally. Height range is from 0 to 4.05 m and distance range is from 1.6m to 100m. 3) It can be used as a conventional automatical level with traditional dumpy level. 4) It is waterproof instrument and can be used in harsh atmospheric conditions. 5) It has a rechargeable battery.	**1M each (any two)**
	viii)	**State any two methods of setting out curve.**	**2M**
	Ans	**1) Chain and tape method (Linear method)** a) By offsets from long chord. b) Versine method of successive bisection of arcs c) Offsets from tangents d) Offsets from chord produced **2) Instrumental Methods** a) By Rankine's method of tangential angle (or deflection angle) b) Two theodolite method c) Tacheometric method	**1M each (for any two)**
Q1b)		**Attempt any <u>TWO</u> of the following.**	**8M**
	i)	**Draw a neat sketches of contour for following** **1) Ridge line** **2) Valley line** **3) Steep slope** **4) Depression**	**4M**

	Ans	    **Depression** **Steep slope**	**1M each**
	ii)	**Define Remote sensing. State the meaning of active and passive system.**	**4M**
	Ans	**Remote sensing:** The method of collecting and interpreting information about terrain and other objects from a distance withoutbeing in physical contact with the object. **Active System: -** The system in which irradiance from artificially generated energy sources such as radar is used then it is called as active system. **Passive System: -** the system in which sun and earth's material are used as natural source so as to radiate electromagnetic energy of variable wave length is called as passive system	**2 M** **1 M** **1 M**
	iii)	**State the procedure for measurement of vertical angle by transit thedolite with suitable sketch.**	**4M**
	Ans	 A vertical angle is the angle between the inclined line of sight and the horizontal. **Procedure :-** 1) Set up the thedolite and level it carefully with reference to the altitude bubble. Place the altitude bubble parallel to any two screws and bring the bubble to the centre by turning both the foot screw inside or outside. Rotate the telescope through 90^0 so that the altitude bubble is on the third foot	**1M (for sketch)** **3M* (for procedure)**

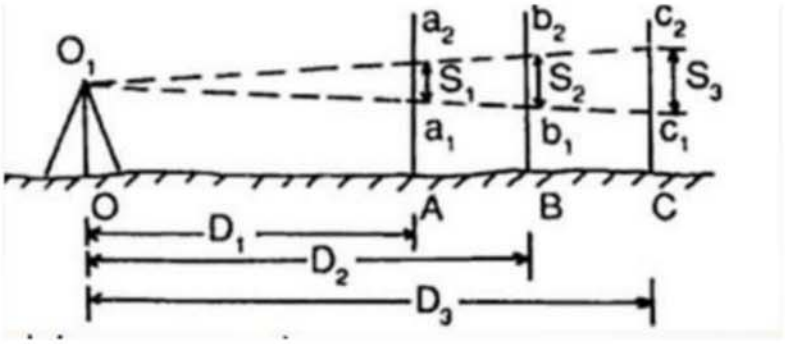
		screw. Bring this procedure till the bubble is central in both the positions. 2) Loosen the vertical circle clamp and direct the telescope in vertical plane towards the object, and bisect it exactly using the vertical circle tangent screw. 3) Read both the verniers C and D. The mean of the two gives the vertical angle. 4) Change the face of the thedolite and repeat the process. The mean of the two readings gives the second value of vertical angle. The average of the two values i.e. face left and face right, gives the values of the required angle. ***(Note: Above procedure is applicable for theodolite having fixed vertical verniers. If procedure for non fixed vertical verniers is written, it may be accepted.)***	
Q.2		**Attempt <u>FOUR</u> of the following**	**16M**
	a)	**State the methods of contour interpolation and explain any one.**	**4M**
	Ans	**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 Bare 25.45m and 27.54m respectively .Taking the contour interval as1m, 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 mrespectively. 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 **3.** This points located by judgment are 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 of81.5,82 and 82.5 between a line PQ of an elevation of 80.00mand 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 lieon parallel representing an elevation of 84.00m. The points atwhich the parallel representing 81.5, 82.0 and 82.5m (shown by X, Y,Z in fig.)may now be pricked through the	**1M (for methods)** **3M (for any one method)**

		position of the contour points on line PQ.  	
	b)	**State any four fundamental characteristics of contour line.**	**4M**
	Ans	1) All points on a contour line have same elevation or RL. 2) Two contour lines of different elevation can not intersect each other except in case of overhanging cliff. 3) When contour lines comes close together then it indicate steep slope. 4) If contour lines are equally spaced, uniform slope is indicated. 5) Closed contour lines with higher values inside indicates hill. 6) Closed contour lines with lower values inside indicates depression.	**1M (each for any four)**
	c)	**Describe the procedure to locate grade contour in a field.**	**4M**
	Ans	In preliminary survey for a road in hilly or mountaneous country, the points are fixed along the given gradient. The line joining such points is called a contour gradient or grade contour. It may be located first approximately by Abeny level and then level may be used for accurate location. **Illustration:** Suppose a falling gradient of 1 in 30 is to be traced on ground Let the RL of starting point =275.300 m Let the distance of next point =40 m. Let back sight of 0.400 m is taken on starting point. H.I.=275.300 + 0.400 = 275.700 m. RL of the next point =275.300 - 40/30 = 273.97 m. Hence the required saff reading =275.700 – 273.970 = 1.73 m. The staff is then held at 40 m from starting point and is moved radially up or down the slope until the reading of 1.73 m is obtained. The point is marked by fixing a peg. The process is repeated until the last point is marked.	**1M (for definition)** **3M (for description)**
	d)	**State different relationship between fundamental axis of theodolite.**	**4M**
	Ans	The desired relationships between fundamental axes of transit theodolite when in perfectadjustment 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 beperpendicular 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.	**1M (Each for any four)**

		5) If the instrument has fixed vernier for vertical circle, it must read zero in leveledposition.	
	e)	**Describe the procedure for measuring magnetic bearing by transit theodolite with suitable sketch.**	**4M**
	Ans	 1) Attach trough compass or circular box compass to theodolite at the place provided. 2) Set up the instrument over the station P, and level it. 3) Set the vernier A to 0 ^{o} of the horizontal circle. 4) Unclamp the lower plate and release the magnetic needle and rotate the instrument about it's outer axis until the magnetic needle shows North and South direction exactly. 5) Loosen the upper plate turn the telescope and bisect the station R exactly by using upper clamp and it's tangent screw. 6) Read both the verniers. The mean of the two reading gives the magnetic bearing of line PR.	**1M (for fig.)** **3M (for procedure)**
	f)	**State any four uses of theodolite.**	**4M**
	Ans	i)To measure horizontal and vertical angles. ii)It can be combined with EDM to measure horizontal andvertical distances. iii) To measure horizontal and vertical distances using principle of tacheometry. iv) To mark line out of complicated and large buildings. v)To mark alignment of road, railway, canal. vi) It can be used for prolonging straight line.	**1M each (for any four)**
Q.3		**Attempt any <u>FOUR</u> of the following**	**16M**
	a)	**List any four modern surveying instruments.**	**4M**
	Ans	Following are the modern surveying instruments i) Total Station ii)One Second Micro-optic Theodolite iii) Electromagnetic Distance Measuring Instrument (E.D.M.) iv) Electronic Digital Theodolite v) Digital level vi) Aerial Camera	**1M each (any four)**
	b)	**Discuss any four advantages of total station over dumpy level .**	**4M**
	Ans	Advantages of total station over dumpy level:- 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	**1M each (any four)**

		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.	
	c)	**State any four component parts of digital level and state their purpose.**	**4M**
	Ans	Following are the component parts of Digital Level: 1. Display screen: To show the program is going on. It has high resolution. 2.Key Pad- For operating the instrument 3.Telescope- For bisecting the object at longer distance with high precision 4.Foot screws- For leveling purpose 5. Focusing screw- Internal focusing is provided, so as to observe the object clearly, it is focused with focusing screw.	**1M each (any four)**
	d)	**State any four application of digital theodolite.**	**4M**
	Ans	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. Primary, secondary, and tertiarytriangulation work can be completed precisely and speedily. 4. For long road and railway bridges, for aligning piers and for determining their centre to centre distance digital theodolite can be used. 5. To determine horizontal distance more precisely.	**1M each (any four)**
	e)	**Describe the procedure to setup total station.**	**4M**
	Ans	Following steps are followed for the set up of total station 1. Set up the tripod approximately over the station point. 2. Remove the plastic cap from tripod and make tripod nearly level by stretching tripod legs. 3. Now fix the total station on tripod and roughly leveled and centered the instrument andpush each leg firmly into the ground. 4. Check the level and center it again . Adjust level by changing leg length. 5. Adjust the three screws of the tribrach to center the bubble of spirit level by using threefoot screws. 6.Accurate leveling is done by using foot screws. 7. Focusing of eyepiece and object glass is done. 8.Check the plate level from time to time during measurement . 9. If total station is used at subsequent stations, proper orientation is to done.	**4M**
	f)	**Draw a neat sketch of circular curve show all the elements.**	**4M**
	Ans	 Where: AB and BC are two tangents.	**2M (for sketch)** **½ M**

		BT_1 and BT_2 are lengths of tangents. BE is Apex distance. DE is Versed sine. R is Radius of curve. T_1DT_2 are length of long chord. T_1ET_2 is the length of curve. I is an angle of intersection. ⊙ is deflection angle T_1 and T_2 are tangent points. Point B is point of intersection.	**each (Any four)**
Q.4		**Attempt any <u>FOUR</u> of the following**	**16M**
	a)	**The following readings were obtained when a figure was traversed using a planimeter in clockwise direction with anchor point outside and with tracing arm set to the natural scale (M= 100 sq.cm) The zero marks of the disc passed the index mark once in the clockwise(positive) direction. IR = 9.625, FR = 1.224. Calculate the area of the figure.**	**4M**
	Ans	Initial reading , I.R. = 9.625, Final reading, F.R. = 1.224 M= 100 cm^2 and C = 0 (Anchor point outside the figure) N = 1 Area = M (F.R. – I.R. ± 10 N +C) Area = 100 (1.224 – 9.625 +(10 X 1) + 0) Area= 159.9 cm^2	**2M** **1M** **1M**
	b)	**State the practical applications of remote sensing in civil engineering field.**	**4M**
	Ans	**1) Silting of storage reservoirs harbors etc**. – Remote sensing technique that makes use of satellite imagery (in the infrared region) gives idea about the silting of reservoir qualitatively and to some extent quantitatively. **2) Location of Percolation Tanks** – The exact location of percolation tanks can be carried out with the help of remote sensing technique, keeping in view that the site required for location of percolation tanks should be on permeablefoundations. **3) Revision of existing toposheets** - The rapid revision and updating of existing topo (graphical) sheets can be carried out speedily with the help of aerial photography (which is also a branch of remote sensing) and satellite imagery. **4) Alignment of new highways and rail routes** – The location of most economical alternative sites for such works can very well be carried out speedily by making use of aerial photographs and satellite imagery. **5) Location of Bridge site**: The existing foundation condition along the proposed bridge construction site can be ascertained with the help of aerial photographs and or satellite imagery. **6) Location of Dam sites**: For gravity, geological investigations of the existing rock in and around the proposed dam site can be carried out by aerial photographs and or satellite imagery. Geological features such folds, faults, dykes, fractures etc. can be determined by the remote sensing technique. **7) Tunneling:** Remote sensing i.e. aerial photography and or satellite imagery of the area helps in furnishing all such information and thus ensures the safety of tunnel during its construction stages. **8) Seepage losses in canals**: Monitoring of soil moisture in and around the canal system can be possible by remote sensing technique i.e. by careful	**1M each (any four)**

		study of aerial photographs and satellite imagery of such areas.	
	c)	**State any four applications of GIS.**	**4M**
	Ans	**Applications of GIS:-** 1) Map making 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.	**1M each (any four)**
	d)	**Explain principle of tachometry with suitable sketch**	**4M**
	Ans	Principle of tachometry is based on principle of similar triangle in which correspondingsides & altitudes are proportional. The ratio of distance of base from apex and length of base is always Constant.  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. $D_1/ S_1 = D_2/ S_2 = D_3 / S_3$ = f/i=Constant Where f=focal length of objective and i= stadia intercept	**2M** **1M** **1M**
	e)	**State any four characteristic of tachometer.**	**4M**
	Ans	1. The value of constant (f/i) = 100. 2. The telescope should be powerful, the magnification should be 20 to 30 times the diameter 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.	**1M each (any four)**
	f)	**Give the classification of curve and Define** **1.Transition curve 2. Reverse curve**	**4M**
	Ans	Classification of curve is as follows- **1) Horizontal curve** a) Simple curve b) Compound curve c) Reverse curve d) Transition curve e) Lemniscate curve	**1M**

2) Vertical curve — **1M**

a) Summit curve

b) Valley curve

Transition curve:- A curve of variable radius is known as a transition curve. In railways ,such a curve is provided on both sides of a circular curve to minimize super elevation — **1M**

Reverse curve:-A reverse curve consist of two arcs bending in opposite directions , their centers lie on opposites sides of the curve . They have one common tangent. — **1M**

Q.5 **Attempt any TWO of the following:** — **16**

a) **The following data was collected in connection with a closed traverse PQRSP.** — **8M**

Line	Length	Bearing
PQ	780	133°45′
QR	2000	32°24′
RS	390	340°00′
SP	?	?

Calculate the missing length of SP and bearing of SP.

Ans — **8M***

Step 1) Calculation of Reduced Bearing :

Reduced bearing of PQ = 180°00′-133°45′= S46°15′E

Reduced bearing of QR = 32°24′= N32°24′E

Reduced bearing of RS = 360°-340°00′=N20°W

Step 2) Calculation of Lattitude :

Lattitude of Line PQ= lcosΘ= 780cos46°15′= - 539.38(as line going towards south is considered as -ve)

Lattitude of Line QR= lcosΘ=2000cos32°24 = 1688.65 (as line going towards north is considered as +ve)

Lattitude of Line RS= lcosΘ=390cos20° = 366.48 (as line going towards north is considered as +ve)

Step 3) Calculation of Departure :

Departure of Line PQ = lsinΘ = 780sin46°15′= 563.44(as line going towards east is considered as +ve)

Departure of Line QR = lsinΘ = 2000sin32°24 = 1071.65(as line going towards east is considered as +ve)

Departure of Line RS = lsinΘ = 390sin20° = -133.38 (as line going towards west is considered as -ve)

Step 4) Calculation of Lattitude and Departure of Line SP

Sum of all latitude = 0

∴ -539.38+1688.65+366.48+L=0

1515.75+L=0

∴Lattitude of line SP = -1515.75

Sum of all departures = 0

∴ 563.44 + 1071.65-133.38+D=0

1501.71+D=0

∴Departure of line SP = -1501.71

Step 5) Calculation of length and bearing of line SP

Length of SP = $\sqrt{L^2 + D^2} = \sqrt{1515.75^2 + 1501.71^2}$ = **2133.68m**

$\tan\Theta = \frac{D}{L} = \frac{1501.71}{1515.75} = 0.990$

$\Theta = \tan^{-1}(0.990) = 44°44′$

∴Reduced Bearing of SP = S44°44′W

∴ Whole circle Bearing of SP = 180°+44°44′ = **224°44′**

Step 6) Table :

Line	Length	Bearing	Reduced Bearing	Lattitude	Departure
PQ	780	133°45′	S46°15′E	- 539.38	563.44
QR	2000	32°24′	N32°24′E	1688.65	1071.65
RS	390	340°00′	N20°W	366.48	-133.38
SP	**2133.68**	**224°44′**	**S44°44′W**	**-1515.75**	**-1501.71**

***Note -Marking scheme**
Calculation of RB 1M, Calculation of latitudesof lines 1 M, calculation of departure of lines 1 M, calculation latitude line SP 1 M, Calculation departure of line SP 1 M, length of line SP 1 M, RB of line SP 1 M, WCB of line SP 1 M

b) Calculate the independent co-ordinates from following data showing calculations. **8M**

Line	Lattitude		Departure	
	N	S	E	W
AB		182.63	313.12	
BC	244.72		470.12	
CD	495.17			318.34
DE		268.70		388.46
EA		288.27		113.34

Ans

Step1) Summation of Northing and Southings.

Northings = 244.72 + 495.17 = 739.89

Southings = 182.63+268.70+288.27=739.6

Algebraic Sum of latitudes = 739.89 - 739.6 = 0.29

Error = 0.29(error +ve correction should be –ve) **2M**

Summation of Easting and Westing

Eastings = 313.12+470.12=783.24

Westings = 318.34+388.46+113.34=820.14

Algebraic sum of Departures = 783.24 - 820.14 = -36.9

Error = -36.9(error –ve correction should be-+ve)

Step 2) Calculation of Corrected latitudes by transit rule.

$$\text{Correction to latitude} = \frac{\text{latitude of that side}}{\text{airthmatical sum of all latitudes}} x \text{total error in latitude}$$

Arithmetic sum of latitudes = 739.89+739.6=1479.49

Correction to latitude AB = $\frac{182.63}{1479.49} x0.29 = 0.035$ **2M**

*Corrected latitude AB = -182.63-0.035=**-182.665***

Correction to latitude BC = $\frac{244.72}{1479.49} x0.29 = 0.047$

*Corrected latitude BC = 244.72-0.047=**244.673***

Correction to latitude CD = $\frac{495.17}{1479.49} x0.29 = 0.097$

*Corrected latitude BC = 495.17-0.097=**495.073***

Correction to latitude DE = $\frac{268.70}{1479.49} x0.29 = 0.052$

*Corrected latitude DE = -268.70-0.052=**-268.752***

Correction to latitude EA = $\frac{288.27}{1479.49} x0.29 = 0.059$

Corrected latitude EA = -288.270-0.059 = ***-288.329***

Step 3) Calculation of Corrected Departures by transit rule.

Correction to departure $= \frac{\text{departure of that side}}{\text{airthmatical sum of all departure}} x \text{total error in departure}$ **2M**

Arithmetic sum of departuress = 783.24+820.14=1603.38

Correction to departure AB = $\frac{313.12}{1603.38} x36.9 = 7.206$

Corrected departure AB = 313.12+7.206 ***=320.326***

Correction to departure BC = $\frac{470.12}{1603.38} x36.9 = 10.819$

Corrected departure BC = 470.12 +10.819 ***=480.939***

Correction to departure CD = $\frac{318.34}{1603.38} x36.9 = 7.326$

Corrected departure CD = -318.34 +7.326= ***-311.014***

Correction to departure DE = $\frac{388.46}{1603.38} x36.9 = 8.940$

Corrected departure DE = -388.46 +8.940= ***-379.520***

Correction to departure EA = $\frac{113.34}{1603.38} x36.9 = 2.609$

Corrected departure EA = -113.34+2.609= ***-110.731***

Step 4) Table of corrected consecutive coordinates and Independent coordinates. **2M**

Line	Corrected Consecutive coordinates				Independent Cordinates	
	lattitude		departure			
	N	S	E	W	N	E
AB		***182.665***	***320.326***		B=817.335	1320.326
BC	***244.673***		***480.939***		C=1062.008	1801.265
CD	***495.073***			***311.014***	D=1557.081	1490.251
DE		***268.752***		***379.520***	E=1288.329	1110.731
EA		***288.329***		***110.731***	A=1000.000	1000.000
Sum	***739.746***	***739.746***	***801.265***	***801.265***		

Sample calculation for Independent co-ordinates

Assume north co-ordinate of A=1000

Deduct southing of AB = -182.665

North Co-ordinate of B =817.335

Add northing of BC =+244.673

North Co-ordinate of C = 1062.008

Continued until A is reached

		Assume East co-ordinate of A=1000 *Add easting of AB* =+320.326 East Co-ordinate of B =1320.326 Add easting **of BC** = 480.939 East Co-ordinate of C = 1801.265 Continued until A is reached.	
	c)	**A Tacheometer fitted with anallatic lens was set up at station O and the following readings were taken on staff held vertical.** Inst.St.n | Staff St.n | Vertical Angle | Stadia Reading O | BM | +7°30′ | 0.900,1.200,1.500 O | B | -2°30′ | 1.100,1.350,1.600 **Find the horizontal distance 'OB' and RL of 'B' if RL of BM is 50.000m . Take the constant as 100.**	**8M**
	Ans	Step 1: To find the height of Instrument (HI) **Instrument station at O and Staff held at BM.** Angle of elevation = Θ = 7°30′ Staff Intercept = 1.500 – 0.900 = 0.6 Multiplying Constant = $\frac{f}{i}$ = 100 and anallatic lens fitted ∴ additive constant =$(f+c)$= 0.	**1M**
		Vertical distance = $V_1 = \frac{f}{i} S \frac{sin2\Theta}{2} + (f+c)\sin\Theta = 100 \times 0.6 \frac{sin2(7°30')}{2} + 0$ = 7.76m	**1M**
		∴ H.I.= BM+h_1- V_1= 50+1.2-7.76 = 43.44m	**1M**
		Step 2 : To find the horizontal distance OB and RL of B. **Instrument station at O and Staff held at B .** Angle of depression = Θ = 2°30′ Staff Intercept = 1.600 – 1.100 = 0.5m	
		Horizontal Distance = $\frac{f}{i} S \cos^2\Theta + (f+c)\cos\Theta = 100x0.5x\cos2°30' + 0$ **= 49.904m (Ans)**	**2M**
		Vertical distance = $V_2 = \frac{f}{i} S \frac{sin2\Theta}{2} + (f+c)\sin\Theta = 100 \times 0.5 \frac{sin2(2°30')}{2} + 0$ = 2.17m	**1M**
		∴R.L.of B = H.I. – V_2 –h_2 = 43.44 – 2.17- 1.350= 39.92 m (Ans)	**2M**
Q.6		**Attempt any <u>TWO</u> of the following:**	**16M**
	a)	**The area enclosed by the contours in a lake are follows:** Contour(m) | 250 | 255 | 260 | 265 | 270 Area(m^2) | 2080 | 8500 | 16500 | 25200 | 33700 **Calculate tne volume of water between 250m and 270m by** **i) Trapezoidal Formula** **ii) Prismoidal Formula**	**8M**
	Ans	<u>Step 1 : To calculate the Volume V by using trapezoidal formula</u> Let A_1=2080 , A_2=8500 , A_3= 16500 , A_4=25200 , A_5=33700	

		By Trapezoidal Formula ; Volume $V=\frac{D}{2}\{A1+A5+2(A2+A3+A4)\}$ where D= common distance between sections $=\frac{5}{2}\{2080+33700+2(8500+16500+25200)\}$ $=2.5\ \{136180\}$ $=340450\ m^3$ Step 2 : To calculate the Volume V by using Prismoidal formula Let A_1=2080 , A_2=8500 , A_3= 16500 , A_4=25200 , A_5=33700 By Prismoidal Formula ; Volume $V=\frac{D}{3}\{A1+A5+4(A2+A4)+2(A3)\}$ where D= common distance between sections $=\frac{5}{3}\{2080+33700+4(8500+25200)+2(16500)\}$ $=339300\ m^3$	**2M** **2M** **2M** **2M**
	b)	**State any four features and any four applications of total station.**	**8M**
	Ans	Following are features of total station. 1. High accuracy and long measuring range. a) Higher accuracy : ±(2mm + 2 ppm) b) Long measuring range with mini prism is 0.9km. c) Long measuring range with single prism is 2.0km. d) Long measuring range with 3 prism is 2.7km. 2. Versatile application program. a) On board data collection, stakeout/ survey road calculation and many more functions. b) Integrated alphanumeric key realizes the quicker operation. c) Large internal memory up to 24000 points. 3. Enhanced absolute encoder a) Adopted absolute encoder which need not require zero set and it can also realize stable measurement with less reading error. b) Superior water-resistant and dust proof. c) No worry about sudden bad weather. Following are applications of total station. 1. With the help of electronic total station, measurement of slope distance, horizontal and vertical distance can accurately and precisely found out. 2. Electronic total station gives the complete basic surveying exercise in order to appreciate how land survey measurements can be used in support of engineering construction and environmental restoration activities. 3. Vertical angle and horizontal angle are accurately measured by electronic total station. 4. Total station for levelling classified as the indirect levelling method and since it is judged that the method can maintain the considerable accuracy, now it has been increasingly used for many public works as road, airport and city etc. 5. Layout of complicated and large projects can be given. 6. Area of field of any shape can be calculated	**4M (any four)** **4M (any four)**

	c)	**Calculate the ordinates on long chord at 5 m interval for a circular curve at radius zoom and long chord of 60 m.**	**8M**
	Ans	Given: a) Interval on long chord = 5m b) Considering Radius of curve =R= 200m c) Length of long chord = L=60m By offsets from long chord method , We know , Mid-ordinate = O_0= R-$\sqrt{R^2-(L/2)^2}$ = 200 - $\sqrt{200^2-(60/2)^2}$ = 2.26m The ordinates calculated at 5 m intervals starting from the center towards the tangent point of left half. O_5 =$\sqrt{R^2-x^2}$ - (R- O_0) =$\sqrt{200^2-5^2}$ - (200- 2.26) = 199.93- 197.73 = 2.19 m O_{10}= $\sqrt{R^2-x^2}$ - (R- O_0) = $\sqrt{200^2-10^2}$ - (200- 2.26) = 199.74-197.73 = 2.01 O_{15} = $\sqrt{R^2-x^2}$ - (R- O_0) = $\sqrt{200^2-15^2}$ - (200- 2.26) = 199.43-197.73 = 1.69 m O_{20} = $\sqrt{R^2-x^2}$ - (R- O_0) = $\sqrt{200^2-20^2}$ - (200- 2.26) = 198.99-197.73 = 1.25 m O_{25} = $\sqrt{R^2-x^2}$ - (R- O_0) = $\sqrt{200^2-25^2}$ - (200- 2.26) = 198.43-197.73 = 0.69 m O_{30} = $\sqrt{R^2-x^2}$ - (R- O_0) = $\sqrt{200^2-30^2}$ - (200- 2.26) = 197.73-197.73=0m ***(Note: Value of radius of curve assumed by student other than 200 m may be considered and the respective values of ordinates should be checked by performing calculations.)***	**2M** **1M** **2M** **1/2M** **1/2M** **1/2M** **1/2M** **1/2M**

---END---