SUMMER– 18 EXAMINATION

Subject Name: ADVANCED SURVEYING **Model Answer** Subject 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 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 some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement 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. N.	Answers	Marking Scheme
Q.1	a) (i) Ans	Attempt any SIX of the following: Define contour interval and Horizontal equivalent. **Contour Interval**: The difference in elevations or R.L's between successive contours is called the contour interval. In general, the same contour interval is used throughout the survey. **Horizontal equivalent**: The horizontal distance between any two consecutive contours is known as horizontal equivalent. It is not constant. It varies according to the steepness of the ground. For steep slopes, the contour lines run close together, and for flatter slopes they are widely spaced.	01 M 01 M
Q.1	a)(ii) Ans	Write the use of Gale's table. The traverse table in which all information related to the theodolite traverse including the relevant independent coordinates, is tabulated, is known as Gale's Table. The Gale's table is used for the computations which are concerned with various observations taken during the theodolite traverse survey.	02 M
Q.1	a)(iii) Ans	State any two situations under which tachometry is preferred. • In broken and uneven country, hilly areas covered with stretches of water, swamps etc. where chaining operation is very difficult, slow and inaccurate, tachometry is best suited. • In rough country both horizontal and vertical measurements can often be made easily where it would be difficult to obtain them by other methods. • When there are many measurements to be made with relatively low degree of precision as for example, in locating contours and filling in detail in a topographic survey, this method is usually the quickest and the best.	Any Two 01 M each
Q.1	a)(iv) Ans	List any four modem survey instruments. 1) One Second Micro Optic Theodolite. 2) Electronic Digital Theodolite 3) Electromagnetic Distance Measuring Instrument (E.D.M.)	Any four 1/2 M for each

		4) Electronic Total Station 5) Digital level 6) Digital tape. 7) G.P.S. instrument.	
Q.1	a)(v) Ans	State any two advantages of total station over dumpy level and theodolite. 1) It has got high accuracy. 2) It is possible to carry out on board data collection. 3) It can be used under bad weather conditions. 4) It has large internal memory which can be used to analyze the data 5) It has long measuring range. 6) Its data storing capacity is more. 7) Data can be transferred into PCs	Any Two 01 M for each
Q.1	a)(vi) Ans	State the two methods of setting out curves. **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) Tachometric method	01 M for each
Q.1	a)(vii) Ans	State Bowditch rule. **Bowditch Rule**: This rule is also termed as the compass rule. It is used to balance the traverse when the angular and linear measurements are equally precise. By this rule the total error in latitude and departure is distributed in proportion to the length of sides. It is the rule most commonly used in traverse adjustment. a) Correction to latitude of any side = (Length of that side/ perimeter of traverse) x Total error in latitude b) Correction to departure of any side = (Length of that side/ perimeter of traverse) x Total error in departure	02 M
Q.1	a)(viii) Ans	State the constant of tachometer. According to the theory of stadia tachometry Horizontal Distance , D = (f/i) x S + (f+c) The quantity f/I is known as the multiplying constant and has a value of 100, and the quantity (f+d) is known as additive constant.	02 M
Q.1	b) (i) Ans	Attempt any TWO of the following: State the application of remote sensing in various fields. Remote sensing has practical applications in the various fields such as civil engineering, geological investigations, archeology, mineralogy, agriculture, forestry, climatology, oil exploration, ground water hydrology and military intelligence etc. Some of the applications of remote is as below: 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 permeable	

		foundations. 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 study of aerial photographs and satellite imagery of such areas. 9) **Environmental Applications:** Remote sensing is useful in weather forecasting. May aspects of ocean becoming better known through remote sensing techniques. Pollution in the form of oil spills and thermal plumes can easily be monitored. Study about Ozone layer depletion and global warming can be possible by using remote sensors. 10) **Mineral Exploration:** Remote sensing techniques have great scope regarding reconnaissance and detailed exploration of nonrenewable resources like minerals and fossil fuels. 11) **Land use or Land cover analysis:** Remote sensing techniques are useful for taking images of large area quickly, and it is cheaper than ground surveying. 12) **Natural Hazards:** In case of earthquakes, landslides, volcanic eruptions and floods and natural hazards, remote sensing can prevent and minimize the damage by analyzing the geological formation of the area, thereby identifying the risk prone areas. It is possible to give specific warning of certain natural hazards and assess the damage caused and thereby help in the rescue and aid operations. 13) **Archaeology:** Archaeological patterns of prehistoric land use may be recognized in remote sensing images. Remote sensors are able to recognize the buried Archaeological important sites.	Any Four 01 M for each
Q.1	b)(ii) Ans	Describe the temporary adjustment of theodolite. Temporary Adjustments : The temporary adjustments have to be carried out at every setup of the instrument before taking observations with the theodolite. The following are the temporary adjustments: i) Setting up the theodolite over a station. ii) Leveling up of theodolite iii) Focusing of eyepiece and iv) Focusing of object glass to remove the parallax.	01 M for each

i) Setting up: Setting up of theodolite includes-

a) Centering it over a station point, and

b) Leveling it approximately by the tripod legs only.

Procedure :

1) Place the instrument over the station by spreading the tripod legs well apart at a convenient height.
2) Suspend a plumb bob from the hook approximately over the station point such as a tack or nail point in a station peg, so that the plumb bob hangs about 2 cm above the within 1 cm. or less, horizontally to the station point.
3) Bring the plumb bob exactly over the station point by moving each leg radially as well as circumferentially, and then press the legs firmly into the ground. By doing this the instrument is approximately leveled also.
4) If shifting head is provided in the instrument, centering can be done rapidly. On hill side to ensure greater stability, place two legs of tripod down hll and the third leg uphill.

ii) Leveling up of theodolite: Accurate leveling is done with reference to the plate level (s) by means of foot screws. The object of leveling is to make the vertical axis truly vertical.

Procedure :

The procedure is given for the most common instrument having one plate level and three foot screws

1) Turn the theodolite about its vertical axis until the plate level is parallel to any pair of leveling screws.
2) Bring the bubble to the centre of its run by turning both foot screws uniformly. By using thumb and forefingers move the foot screws either towards each other or away from other.
3) Turn the instrument through 90^0 so that the bubble line will be at right angle to its previous position. Now, move only the third foot screw either in or out till the bubble is brought to the centre of its run.
4) Repeat the process until finally the plate bubble is exactly centered in both the positions.
5) Now rotate the theodolite about the vertical axis through 360^0. The bubble will remain central provided it is in correct adjustement. The vertical axis is thus made truly vertical

   (Note : The bubble moves in the direction of movement of left thumb)

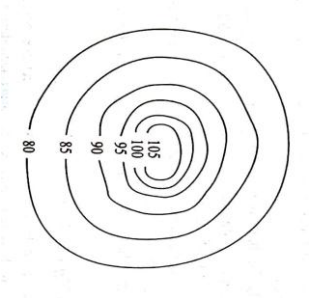
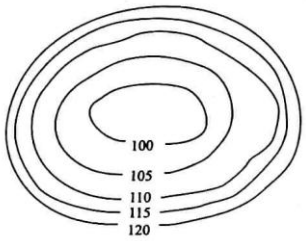
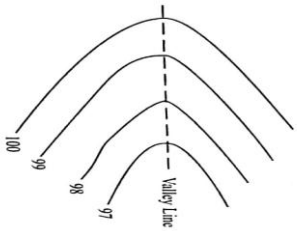
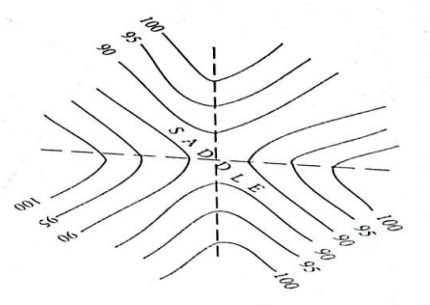
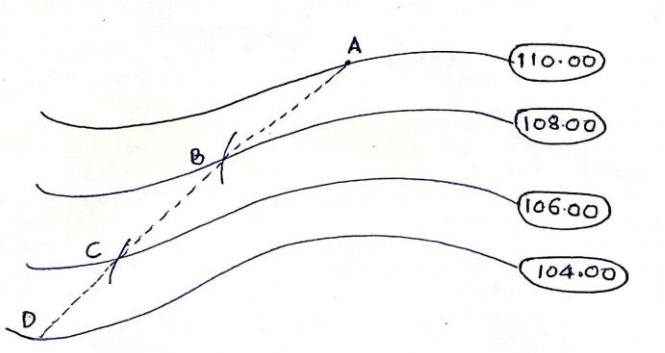
iii) Focusing the eye piece :

The object of focusing the eye piece is to make the cross hairs on diaphragm distinct and clear. To do this, direct the telescope towards the sky or hold a sheet of white paper in from of the object glass, and move the eye piece circumferentially or in or out until the cross hairs are seen sharp and black.

iv) Focusing of object glass :

The object of focusing the glass is to bring the image of the object formed by the object glass exactly in the plane of cross hairs. If not done accurately, there will be an apparent movement of the image relatively to the cross hairs when the observer moves his eye up and down. This effect is known as parallax. The parallax can be removed by the sharp focusing until the image appears sharp and clear.

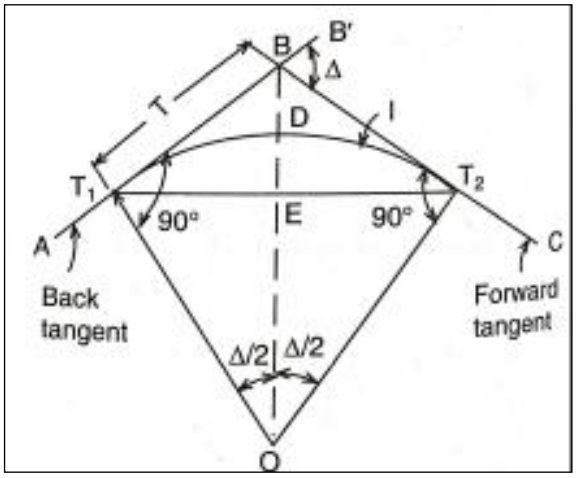
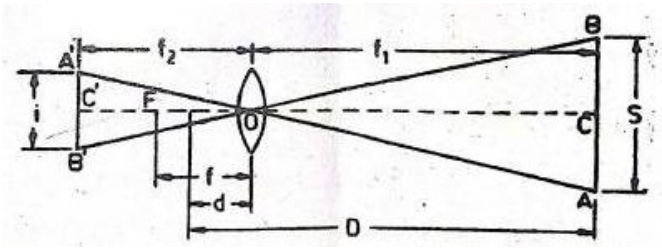
Q.1	b)(iii)	Draw a neat sketch of contour for the following. Assume suitable contour values and	

	Ans	show the same. 1) Hill 2) Valley 3) Pond 4) Saddle Hill  Pond  Valley  Saddle  	01 M for each
Q.2	a) Ans	Attempt any FOUR of the following: Define grade contour. Give the procedure to locate grade contour on contour map with suitable sketch. **<u>Grade contour</u>**: In preliminary survey for a road in hilly or mountainous 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 Abney level and then level may be used for accurate location. All the points on a contour have the same elevation. But all the points on a contour gradient do not have the same elevation but all of them lie on the same gradient. Suppose a falling gradient 1 in 30 is to be traced on a contour map from A as shown in fig.  	02 M 01 M

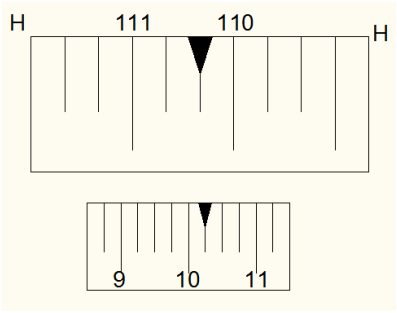
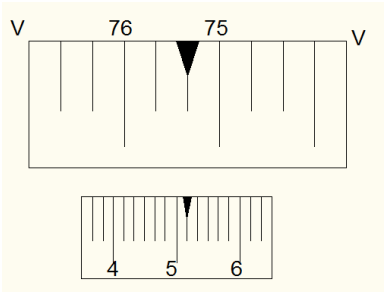
		Contour interval is 2 m as shown in fig. So to obtained falling gradient 1 V in 30 H Horizontal distance between A and next point on contour of RL =108.00 = 30 x 2/1 =60 m. So from A draw a arc of 60 m (convert it into scale) bisecting contour of RL. 108.00 and obtained point B. Now the line joining A and B is having a gradient 1 in 30. Similarly others points i.e. C ,D etc may be obtained.	01 M
Q.2	b) Ans	The following readings were recorded by a planimeter with the anchor point inside the figure IR = 9.377, F.K. = 3.336 M = 100 cm^2 and C = 23.521. Calculate the area of the figure when it is observed that the zero marks of the dia. passed the index mark once in the anti-clockwise direction. Initial reading , I.R. = 9.377, Final reading, F.R. = 3.336 M= 100 cm^2 and C = 23.521 (Anchor point inside the figure) N = -1 Area = M (F.R. – I.R. ± 10 N +C) = 100 (3.336 – 9.377 -10 X 1 + 23.521) = 748 cm^2	02 M 02 M
Q.2	c) Ans	Mention different sources of errors in theodolite surveying. Basically there are three sources of errors in theodolite survey: I) Instrumental error II) Natural error III) Personal error **Instrumental error:** This error is mainly due to – i) Imperfect adjustment of the instrument ii) Structural defects in the instrument i) **Error due to imperfect adjustment of plate level :** If the upper and lower plate are not horizontal, when the bubble or bubbles in two plate levels are both centered, the vertical axis will no be truly vertical. This will also cause an error in prolonging line by plunging the telescope. ii) **Error due to line of collimation not being perpendicular to the horizontal axis:** If the line of sight is not perpendicular to the horizontal axis, it will no revolve in a plane when the telescope is revolved on the horizontal axis. iii) **Error due to horizontal axis not being perpendicular to vertical axis:** If the horizontal axis not being perpendicular to the vertical axis, the line of sight will move in an inclined plane when the telescope is raised or lowered. iv) **Error due to the axis of telescope level and the line of collimation are not parallel:** If the line of collimation is not parallel to the axis of telescope bubble, measured vertical angle will be incorrect since the zero line of vertical vernier is not a true line of reference. v) **Error due to eccentricity of inner and outer axes :** If the centre of the vernier plate does not coincide with the centre of graduated circle, the angle read will be incorrect. vi) **Error due to eccentricity of verniers :** The error is introduced when the zeros of the verniers are not at the ends of the same diameter	02 M

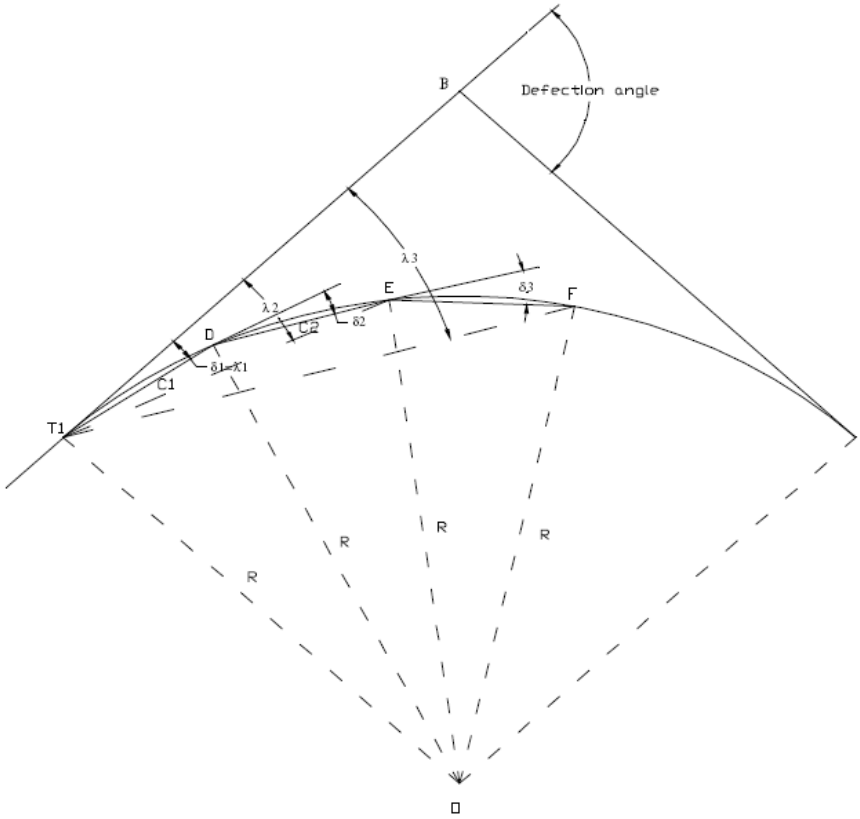
		vii) **Error of graduation:** The graduations on good transit are not so nearly correct that errors from imperfect graduations are negligible except in work of high precision. **Personal Error:** The personal errors includes (i) errors in manipulation and (ii) Error in sighting and reading. **(i) Errors in manipulation :** a) **Inaccurate centering:** If the instrument is not accurately centered over the station, the observed angles will be incorrectly measured. The angular error due to incorrect centering varies inversely as the length of sights. b) **Error in leveling:** This error is similar to the error due to non-adjustment of plate levels. c) **Slip:** This error occurs because of poor clamping or loose shifting head or instrument is not firmly fixed on tripod. d) **Operating wrong tangent or slow motion screws:** This mistake is generally made due to confusion or lack of knowledge. **(ii)Errors in sighting and reading:** Failure to sight exactly on a point may be due to parallax, unfavorable atmospheric conditions, poor quality of telescope, inaccurate work either in manipulating the transit or in holding the sight pole. **Natural Error :** Sources of natural error are 1)Settlement of tripod 2) Unequal atmospheric refraction. 3) Unequal expansion of parts of the telescope due to temperature changes. 4)Wind producing vibrations of the transit or making it difficult to plumb correctly.	01 M 01 M
Q.2	d) Ans	Write four applications of GIS. GIS technology is helpful in various for the use of geographic data. It is useful for the following purposes. 1) **Map making:** Custom maps, showing selected data layers, can be displayed on the computer or generated as a hard copy product. The user can define the scale and the area to be mapped. Data layers can be added or deleted to fit the user's requirements. 2) **Site selection:** Where is the best location for a county landfill, a new restaurant, or a highway by pass?. The GIS user first defines the site selection criteria. For finalizing a landfill site, the criteria may include the geology, soil type, current land use, location of protected lands or environmentally sensitive areas, proximity to roads, the cost to purchase the land etc. 3) **Network Analysis:** How does a school system determine school bus routes and schedules?. The administrators can use GIS for analyzing factors such as travelling distance, speed limits, student's addresses, school locations, and class schedules to select routes that minimize the number of buses and fuel costs. 4) **Environmental Applications:** What is the potential impact of a proposed new housing or industrial development on a community's drinking water supply? Which forest areas need to be preserved to prevent damage to economically important, recreational fishing streams?. Is a proposed new drinking water supply located too close to an abandoned waste site? In each of these examples, GIS can be used to integrate and evaluate multiple data layers and attributes and then generate information that enables public officials and resource managers to make more informed decisions.	01 M for each

Q.2	e) Ans	State four component parts of a micro-optic theodolite and state their purpose. Components parts of Micro Optic Theodolite i) Telescope ii) Magnification with standard eyepiece iii) Level Tube iv) Automatic vertical and horizontal reading circles. v) Foot screws. Tribrach and Trivet vi) Tripod top • Telescope is used for the bisecting the object and getting the proper image of it. CCD sensors have been added to the focal plane of the telescope allowing both auto-targeting and the automated measurement of residual target offset. • Eyepiece is used for focusing towards the object • Automatic vertical and horizontal reading circles are graduated to finest degree of accuracy of 1^0 interval and micrometer interval is 6” • With the help of automatic index the vertical angle measurement is not only quick but also accurate.	02 M for components 02 M for purposes.
Q.2	f) Ans	Write any four features of total station. Following are the features of total station 1. It has got high accuracy of the range of ± 2mm 2. It has long measuring range i) With mini prism – 0.9 km ii) With single prism – 2 km ii) With three prism – 2.7 km 3. On board data collection 4. Enhanced absolute encoder 5. Can be used under bad weather conditions 6. Large internal memory. 7. It is possible to get access to any desired programme and mode of selection 8. The surveyor can achieve accurate measurements even without the face left and face right (i.e. telescope in normal and reversed position) observations. 9. The desired information is displayed on the screen , hence it has easy to read arrangement. 10. The instrument is provided with a built in sensor for the surrounding atmospheric parameters due to which automatic atmospheric correction is possible. 11. If guidance is required during the course of operation of the instrument, by pressing ‘HELP’ key, guiding message displays for the subsequent operation. 12. Higher distance resolution can be possible within fraction of second. 13. The tangent screws which are provided with two speed mechanism which makes accurate target acquisition at faster rate.	Any Four 01 M for each

Q.3	a) Ans	Attempt any FOUR of the following: State the classification of electronic distance meter. Following are the classifications of electronic distance meter. **A) Based on the type of carrier wave used.** i) EDM having visible light waves. ii) EDM having invisible infra-red waves. iii) EDM having micro waves iv) EDM having long radio waves. **B) Based on the range of the EDM** i) Short range instrument (Upto 10 Km) ii) Medium range instrument (Upto 60 Km) iii) Long range instrument (Upto 150 Km) **C) Based on the appearance of EDM** i) Mount type EDM. ii) Built in type EDM **D) Based on the reflected and transmitted wave** i) Reflected type EDM e.g Geodimeters ii) Transmitting type EDM e.g. Tellurometer	01 M 01 M 01 M 01 M
Q.3	b) Ans	Draw a neat sketch of simple circular curve showing all elements.  AB = Back tangent or rear tangent BC = Forward tangent T1 and T2 = Tangent points B= Vertex or point of intersection. Δ = Deflection angle BD = External distance T1T2 = Long chord T1DT2 = Length of curve	02 M 02 M
Q.3	c) Ans	Explain principle of stadia method. The principle of stadia method is that in two similar triangles corresponding sides and altitudes are proportional.  Let,	01 M

		O = Optical centre of object glass. A'C' and B' = Top, axial and bottom hair lines. B'A' = i = Interval between stadia lines. BA = S= Staff intercept. f = Focal length of object glass. f1= Horizontal distance from the optical centre to the staff. f2 = Horizontal distance from the optical centre to the image of the staff. d = Horizontal distance from the optical centre to the vertical axis of the tacheometer. D= Horizontal distance from the vertical axis of the instrument to staff. In Δ AOB and ΔA'OB' AB/A'B' = OC/OC' = f1/f2 Or S/i = f1/f2 By the formula of lenses 1/f = (1/f1) +)1/f2) i.e (f1/f) – 1 = f1/f2 = S/i Or f1 = (f/i) S + f The distance from the vertical axis of instrument to staff = f1 +d Therefore **D = f1 + d = (f/i)S + (f+d)**	03 M
Q.3	d) Ans	Enlist any six uses of contour. Following are the uses of contours i) Contours are helpful to know the nature of ground. ii) For determination of most economical site for the dams and reservoirs. iii) For estimating volume of water impounded in a reservoir. iv) For determining indivisibility of two given points. v) Useful for the location of highways, railways, canals, pipelines etc. vi) For the location of structures such as buildings, bridges etc.	04 M
Q.3	e) Ans	Write down the procedure for determination of tachometric constant. 1) In this method value of (f+d) is obtained by direct measurement and value of (f/i) is computed. Steps: i) Sight any distant object and focus it carefully. ii) Measure the distance between object glass and the plane of cross hair with scale, let it be (f) iii) Measure (d) from the object glass to the vertical axis of the instrument. iv) Measure the distance D1, D2, D3 etc, from the instrument and let S1,S2,S3 etc is corresponding staff intercept. v) In formula D = (f/i) S + (f+d), knowing the value of (f+d) and measured distance D1,D2,D3 etc several values of (f/i) calculated and mean of it is the value of constant (f/i) **OR** 2) Alternative method to determine constants of (f/i) and (f+d) is to measure two definite distances D1 and D2 and find the corresponding staff intercepts S1 and S2 on the staff held at these positions.	04 M For any one method

		By suing equation D1 = (f/i) S1 + (f+d) --- 1 D2 = (f/i) S2 + (f+d) --- 2 By solving these equations values of constant (f/i) and (f+d) can be determined.	
Q.3	f) Ans	Show the following readings on windows of micro-optic Theodolite in measurement of horizontal and vertical angle. (i) Horizontal angle = 110°30 '15 " (ii) Vertical angle = 75°25'10"   Horizontal angle = 110˚30’15” Vertical angle = 75˚25’10” **Note: It may change as per make of instrument.**	02 M for each
Q.4	a) Ans	Attempt any FOUR of the following: What is meant by zero circle? State the advantages of digital planimeter over polar planimeter. **Zero Circle**: Zero circle is defined as the circle round the circumference of which if the tracing point is moved, no rotation of the wheel cause but the wheel is simply slide on the paper without any change in reading . This condition occurs when the line joining the anchor point to the wheel is at right angles to the line joining the tracing point to the wheel. **Advantages of Digital planimeter over Polar planimeter** Following are the advantages of Digital planimeter over Polar planimeter i) No calculations are required for area. ii) Less time required.	02 M 02 M
Q.4	b) Ans	Enlist the advantages and disadvantages of total station. **Advantages of total station**. i) Quick setting of the instrument on the tripod using laser plummet. ii) On- board area computation programme to compute the area of the field. iii) Greater accuracy in area computation. iv) The field jobs are finished, the map of the area with dimensions is ready after data transfer v) Its reduce the time & also it’s measure up to 3 to 5 Km distance. vi) Full GIS creation **Disadvantages of total station.** i) Instrument is costly. ii) It might be troublesome for the surveyor to investigate and check the work when surveying.	Any Four 02 M Any Four 02 M

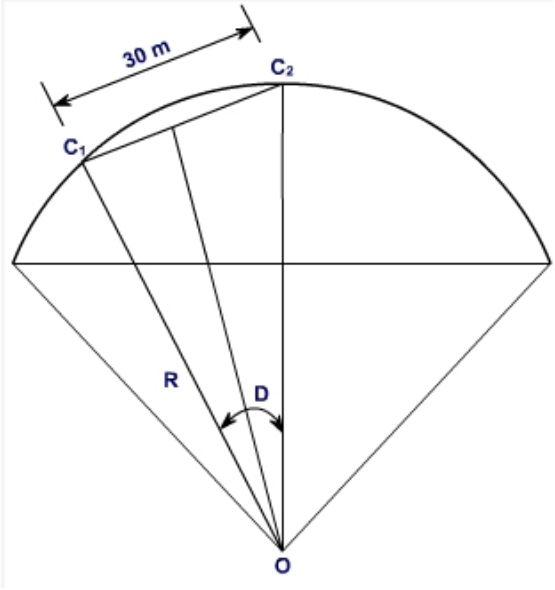
		iii) Conducting surveys using total station, skilled personnel are required. iv) For an overall check of the survey, it will be necessary to return to the office and prepare the drawings using appropriate software	
Q.4	c) Ans	Explain the setting of curve by Rankine's deflection angle method.  **Procedure for setting out of curve** 1) Locate the tangent points T1 and T2 on the straights AB and CB. 2) Set up the theodolite at the beginning of the curve T1. 3) With the vernier A of the horizontal circle set to zero, direct the telescope of the ranging rod fixed at the point of intersection B and bisect it. 4) Unclamp the vernier plate and set the vernier A to the first tangential angle @1, the telescope being thus directed along T1D. 5) Measure along the line T1D, the length equal to first sub-chord (C1) thus fixing first point D on the curve. 6) Unclamp the vernier plate now and set the vernier A to the second total tangential angle @2 , the line of sight is now directed along T1E. 7) With the zero end of chain or tape at D1 and with a arrow held at distances of D1E=C2 (second chord or say normal chord),swing the chain about D1 until the line of sight bisects the arrow, thus fixing the second point Eon the curve. 8) Repeat the process until the last point T2 is reached.	01 M 03 M

Q.4 d) Ans. Differentiate between active system and passive system of remote sensing. — 01 M for each point

Active System	Passive System
Artificial energy is used as a source	Naturally emitted energy is used as a source
In active system sensors are able to obtain measurement anytime (day & night)	In passive system sensors can obtain measurement in day time only
Active system used their own source for illumination.	In passive system sensors can detect energy when the naturally occurring energy is available
It is costlier	It is economical

Q.4 e) Ans. Derive the relation between radius and degree of curve. — 01 M

The degree of a curve is defined as the angle subtended at the centre of the curve by a chord of 30 m length.



Let D be the degree of a curve i.e., it is the angle subtended at its centre O by a chord C1C2 of 30 m length as shown in fig.

Thus,

$\sin(D^0/2) = 15/R$

$R = 15 / \sin(D^0/2)$

When D is small , $\sin(D/2) = (D/2)$ radians

Therefore,

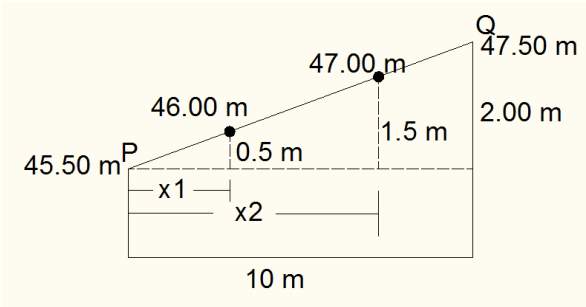
$R = 15 / [(D/2)^* (\Pi/180)]$ — 03 M

$R = 1718.89/D$

Therefore,

R = 1719/D degrees

If chord is 20 m then R = 1146/D degree

Q.4	f)	Points P and Q are two ground points at a distance of 10 m with their reduced levels 45.50 and 47.50 m respectively. Interpolate the contours of 46 and 47 m between P and Q.	
	Ans.		02 M
		Let, X_1 be the distance of contour of RL 46.00 from P From fig. By similarity of triangle $(2/10) = (0.5/X_1)$ Therefore X_1 = 2.5 m from P	02 M
		Similarly X_2 be the distance of contour of RL 47.00 from P From fig. By similarity of triangle $(2/10) = (1.5/X_2)$ Therefore X_2 =7.5 m from P	
Q.5	a)	Attempt any TWO of the following: An incomplete traverse table is obtained as follows:	

Line	Length (m)	Bearing
AB	100.00	?
BC	80.50	$140^0 30'$
CD	60.00	$220^0 30'$
DA	?	$310^0 15'$

Ans. Calculate the length of DA and bearing of AB.

Line	Length (m)	WCB	R.B.	Latitude L=lcos θ	Departure D=lsin θ
AB	100.00	?	θ	100 cos θ	100 sin θ
BC	80.50	$140^0 30'$	$S39^0 30'E$	$-80.5\cos 39^0 30' = -62.12$	$+80.5\sin 39^0 30' = +51.20$
CD	60.00	$220^0 30'$	$S40^0 30'W$	$-60.0\cos 40^0 30' = -45.62$	$-60.0\sin 40^0 30' = -38.97$
DA	?	$310^0 15'$	$N49^0 45'W$	$l\cos 49^0 45' = +0.646\ l$	$-l\sin 49^0 45' = -0.763\ l$

04 M

For closed traverse ΣL = 0 and ΣD = 0

$100\cos\theta - 62.12 - 45.62 + 0.646\ l = 0$ ----------1

$100\sin\theta + 51.2 - 38.97 - 0.763\ l = 0$ ----------2

		100cosθ = 107.74 – 0.646 l ---------------------------A 100sinθ = -12.23 + 0.763 l ----------------------------B Squaring and adding eqn. A and B $(100\cos\theta)^2 = (107.74 - 0.646\,l)^2$ $= 11607.9 - 139.2\,l + 0.417\,l^2$ $(100\sin\theta)^2 = (-12.23 + 0.763\,l)^2$ $= 149.57 - 18.66\,l + 0.58\,l^2$ $11607.9 + 149.57 - 139.2\,l - 18.66\,l + 0.417\,l^2 + 0.58\,l^2$ $= 11757.47 - 157.86\,l + l^2$ $10000 = l^2 - 157.86\,l + 11757.47$ $L^2 - 157.86\,l + 1757.47 = 0$ Solving quadratic equation **l = 145.8 and 12.05** Considering l = 145.8 and putting in eqn. A 100cos θ = 107.74 – 0.646 (145.8) = 13.553 cos θ = 0.136 --------------------------------C Put l = 145.8 in eqn. B 100sinθ = -12.23 + 0.763(145.8) sin θ = 0.99 tan θ = sin θ / cos θ = 0.99/0.136 = 7.28 $\theta = \tan^{-1} 7.28$ $= 82^0 11'$ cos θ and sin θ both are +ve AB lies in 1st quadrant. **Bearing of AB = N82⁰11'E** **OR** Considering l = 12.05 and putting in eqn. A 100cos θ = 107.74 – 0.646 (12.05) = 99.96 cos θ = 0.999 --------------------------------C Put l = 12.05 in eqn. B 100sinθ = -12.23 + 0.763(12.05) sin θ = - 0.02898 tan θ = sin θ / cos θ = 0.02898/0.999 = 0.029 $\theta = \tan^{-1} 0.029$ $= 1^0 40'$ cos θ is + ve and sin θ is -ve AB lies in IV quadrant. **Bearing of AB = N1⁰40'W** Note: There may be variation in minutes.	02 M 02 M **OR** 02 M
Q.5	b) Ans.	Explain sources of error in Theodolite. i. Non adjustment of plate bubble: When the plate levels are centered the vertical axis may not be truly vertical. This would cause an error in angle measurement. ii. Line of collimation not being perpendicular to horizontal axis.	Any four 02 M for each

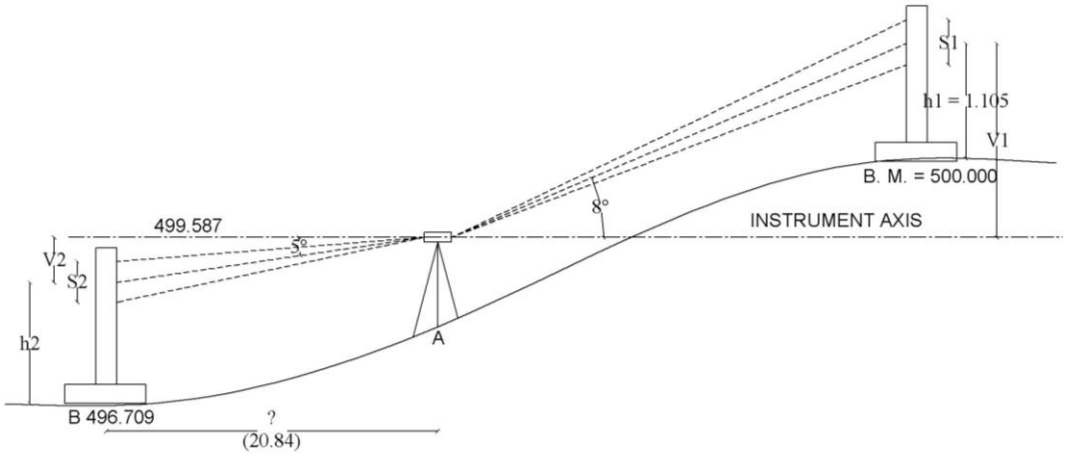
iii. Horizontal axis not being perpendicular to vertical axis.
iv. Line of collimation not being parallel to axis of telescope.
v. Eccentricity of inner and outer axes.
vi. Gradation not being uniform.
vii. Vernier being eccentric.
viii. The clamp screws may slip.

Q.5 c) A tacheometer was set up at station A and following readings were taken on a staff held vertically.

Instrument Station	Staff Station	Vertical angle	Hair Reading	Remark
A	B.M.	8^0	1.050, 1.105, 1.160	R.L. of B.M.=500 m
A	B	-5^0	0.950, 1.055, 1.160	
The constant of instrument was 100. The instrument was fitted with analytic lens calculate the distance AB and R.L. of B.				

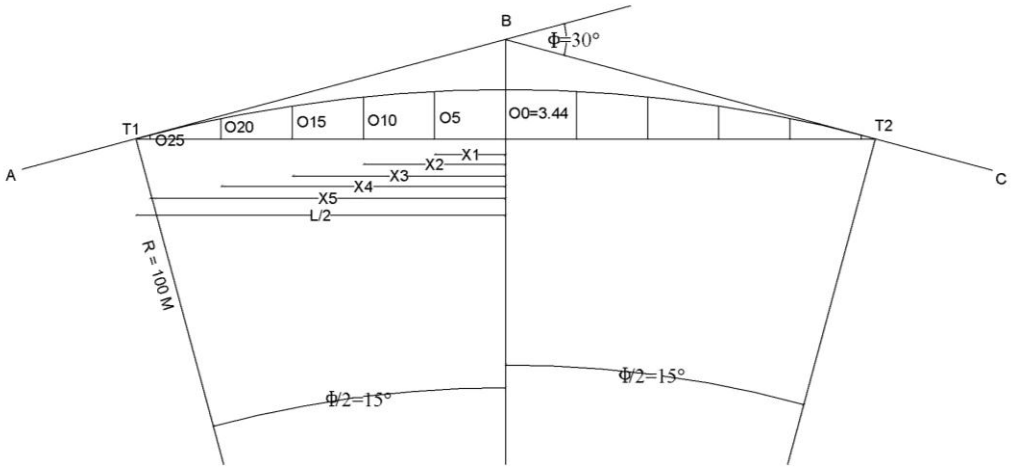
Ans.

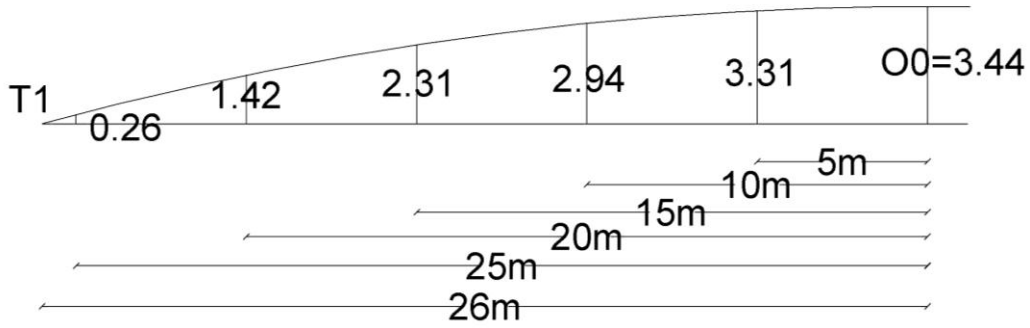
Data: B.M. =500.00 m
(f / i) = 100
(f + d) = 0



01 M

$S_1 = (1.160 - 1.050) = 0.11$, $\theta_1 = 8^0$
$h_1 = 1.105$ 01 M
$V_1 = (f / i)S_1 \times (\sin 2\theta_1 / 2) + (f + d)\sin\theta$
$= 100 \times 0.11 \times [(\sin 16) / 2)] + 0$
$= 11 \times 0.138$
$= \mathbf{1.518}$ ---------- 01 M
Elevation of Instrument axis = R.L. of B.M. + $h_1 - V_1$
$= 500.000 + 1.105 - 1.518$
$= \mathbf{499.587\ m.}$ ---------- 01 M
$V_2 = (f / i)S_2 \times (\sin 2\theta_2 / 2) + (f + d)\sin\theta$ $S_2 = (1.160 - 0.950)$
$= 100 \times 0.21 \times [(\sin 10) / 2)] + 0$ $= 0.210$ 02 M
$= \mathbf{1.823\ m}$ $h_2 = 1.055$
R.L of B = Elevation of I.A. – $V_2 - h_2$ $\theta_2 = 5^0$
$= 499.587 - 1.823 - 1.055$
$= \mathbf{496.709\ m.}$ ---------- 01 M
l(AB) = ?

		$D = (f / i)\, S_2 \cos^2 \theta_2 + (f + d) \cos \theta_2$ $= 100 \times 0.21 \cos^2 5 + 0$ $=$ **20.84 m.** ----------	01 M
Q.6	a)	Attempt any TWO of the following: Two tangents AB and BC intercept at a point B at 150.5 m chainage. Calculate all the necessary data for setting out a circular curve of 100 m radius and deflection angle 30° by the method of offsets from the long chord.	
	Ans.		
		Length of Long chord = $2R\sin \phi/2$ $= 2 \times 100 \sin 15$ $= 52$ m. ----------	01 M
		Half-length of Long chord = 52/2 = 26 m Length of Tangent = $R \tan \phi/2$ $= 100 \times \tan 15$ $= 26.80$ m. ----------	01 M
		Chainage at T_1 = 150.50 – 26.80 = 123.70 m. ----------	1/2 M
		Length of curve = $\pi R \phi/180$ $= \pi \times 100 \times 30/180$ $= 52.35$ m. ----------	01 M
		Chainage of T_2 = 123.70 + 52.35 = 176.05 m ----------	1/2 M
		The ordinates are calculated at 5 m interval from the center towards T1 for the left half. $O_0 = R - SQRT[R^2 - (L/2)^2]$ $= 100 - SQRT[100^2 - 26^2]$ $=$ **3.44 m.** $O_5 = SQRT[R^2 - X_1^2] - (R - O_0)$ $= SQRT[100^2 - 5^2] - (100 - 3.44)$ $=$ **3.31 m.** $O_{10} = SQRT[100^2 - 10^2] - 96.56$ $=$ **2.94 m.** $O_{15} = SQRT[100^2 - 15^2] - 96.56$ $=$ **2.31 m.** $O_{20} = SQRT[100^2 - 20^2] - 96.56$ $=$ **1.42 m.**	1/2 M for each ordinate

		O_{25} = SQRT[$100^2 - 25^2$] – 96.56 = **0.26 m.** O_{26} = SQRT[$100^2 - 26^2$] – 96.56 = **0**  	1/2 M
Q.6	b)	Find the quantity of water from the contour map of a reservoir the following contour areas were recorded by planimetered the top water level is 200 m and lowest plant in the reservoir is 180 m.	
		<table><tr><td>Contour (m)</td><td>200</td><td>195</td><td>190</td><td>185</td><td>180</td><td>175</td></tr><tr><td>Area in m^2</td><td>3850</td><td>3450</td><td>2600</td><td>800</td><td>450</td><td>200</td></tr></table>	
	Ans.	A_1 = 3850, A_2 = 3450, A_3 = 2600, A_4 = 800, A_5 = 450, A_6 = 200. ----------	02 M
		Contour interval = 5 m = h; Use trapezoidal formula. ----------	01 M
		V = h/2 [(A_1 + A_n) + 2(A_2+ A_3 +--------A_{n-1})] ----------	02 M
		= 5/2 [3850 + 200) + 2(3450 + 2600 + 800 + 450)]	
		= 2.5[4050 + 2(7300)]	03 M
		= 46625 m^3	
		The quantity of water in the reservoir = 46625 m^3.	
Q.6	c)	Describe the use of digital theodolite for measurement of horizontal and vertical angle.	
	Ans.	Digital Theodolite for measurement of horizontal and vertical angle. Measuring horizontal angle: 1. Setting up Tripod: • Open the tripod legs sufficiently enough for the instrument to be stable. • Assure that the station point is located directly beneath the center hole in the tripod below. • Firmly press tripod shoes into the ground. • Level the top surface of tripod head. 2. Centering: • The centering can be performed either by pimb bob or optical plummet. • Suspend the plumb bob from the hook provided at tripod mounting screw. • Slightly loose the screw and carefully slide the instrument about tripod head, such that plumb bob is exactly over station point. 3. Leveling: • Loosen the upper plate clamp, rotate the instrument and keep plate level parallel with any two leveling screws. • Bring the plate bubble in the center by moving leveling screws. • Turn instrument through 90^0 in horizontal plane and move the bubble to the center by third screw.	01 M 01 M

		• Repeat the steps so that bubble remains in center for all positions. 4. Removing /eliminating parallax: • Focusing eye piece and object glass eliminate the parallax. 5. Initial setting procedure: • Turn on the power switch • Set minimum angle unit (5" or 10"); vertical 0^0 orientation with horizontal or zenith or compass angle unit. • Automatic vertical compensation. • Automatic power switch. 6. Operation: i. Horizontal angle zero reset: • Depress the (RST) key to reset the horizontal angle to 0^0 • Depress the (R/L) key to measure angle counter clockwise/clockwise. • Depress (Hold) key. Direct telescope towards object say A. HA – $0^0$0'0". Bisect the object precisely. • Release (Hold); Depress (Hold) key again rotate telescope in horizontal plane clockwise. • Bisect the object B precisely. HA – $30^0$20'5". • Fix clamping screw, read the displayed angle. • By pressing hold key and releasing the upper clamping screw. The number of repetitions can be taken and average angle can be worked out. ii. Vertical angle zero reset: • The orientation of vertical 0^0 reference angle can be set in the initial setting mode for either zenith 0^0, horizontal 0^0 or compass scale. • With reference to above setting VA is measured by moving the telescope in the vertical plane. • By depressing (%/VA) key the angle can be measured in 0^0 or % indicating grade measurement.	01 M 01 M 02 M 02 M