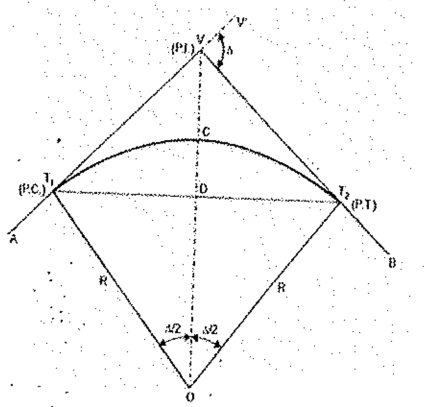
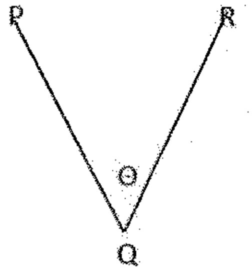
Scheme of Evaluation
Scoring Indicators

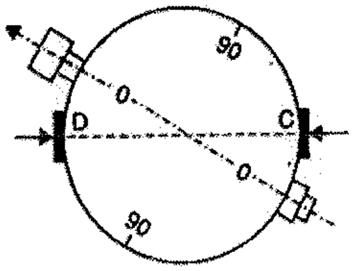
Revision: 2015 — Course Code : 3012
Course Title : Surveying II

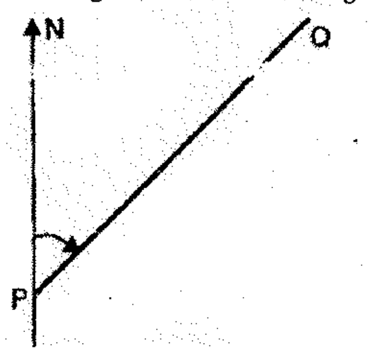
Q No	Scoring Indicator	Split up score	Sub Total	Total
	PART A			
I 1	Turning the telescope in a horizontal plane Right swing – when telescope is turned clock wise Left swing – when the telescope is turned anti clockwise			2
2	The *latitude* of a survey line may be defined as its co-ordinate length measured parallel to an assumed meridian direction *(i.e.* true north or magnetic north or any other reference direction). The latitude *(L)* of the line is *positive* when measured northward (or upward) and is termed as *northing* ; the latitude is *negative* when measured southward (or downward) and is termed as *southing.* $L = l\cos\theta$ The *departure* of survey line may be defined as its co-ordinate length measured at right angles to the meridian direction *The departure (D) of the line is positive when measured eastward and is termed as easting. The departure is negative when measured westward and is termed as westing* $D = l\sin\theta$	1 1		2
3	D = Ks+c $K = \frac{f}{i}$ and c = f+ d f = focal length of objective d = distance of vertical axis of instrument from O i = stadia interval K is known as multiplying constant C is known as additive constant			2
4	• M =CD $R\left(1-\cos\frac{\Delta}{2}\right) = R \text{ versin } \frac{\Delta}{2}$ • Mid ordinate of the curve is also known as versed sine of the curve			2

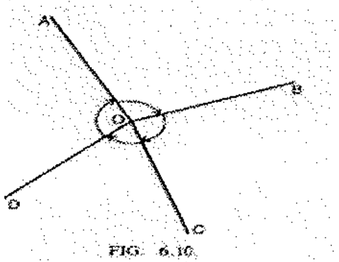
				
5	Linear Methods: • By ordinates or offsets from long chord • By successive bisection of arcs • By offsets from the tangents • By offsets from chords produced (or by deflection distances) Angular Methods: • Rankine's method of tangential (or deflection) angle (one theodolite) • Two theodolite method • Tacheometric method	1 1		2
	PART B			
II 1.	The setting of the theodolite over a station at the time of taking any observation is called temporary adjustment Adjustments which have to be made at every set up of the instrument and preparatory to taking observations with the instrument – Setting up of the theodolite over a station – Levelling up – Elimination of parallax Setting Up: This includes two operations – Centering theodolite over a station – Approximate levelling by tripod legs Centering theodolite over a station – By centering of a theodolite over a station is meant by the setting of the centre over a station mark such as a tack or wire nail in a station peg. – This can be done by means of a plumb bob suspended from the hook – By moving the leg radially, the plumb bob is shifted in the direction of the leg – This does not affect the level status of the instrument. – By moving the leg circumferentially or side ways considerable change in the inclination is effected without disturbing the plumb bob – The approximate levelling is done either with reference to a small circular bubble provided on tribrach or is done by eye judgement Levelling Up – The operation of making the vertical axis truly vertical is known as levelling of Theodolite. – i) Turn the upper plate plate until the longitudinal axis of the plate level is approximately parallel to a line joining any two levelling screws.	2 2		6

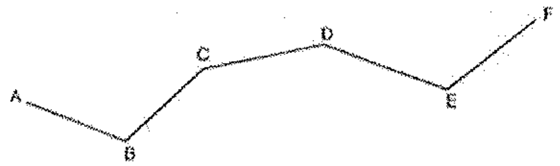
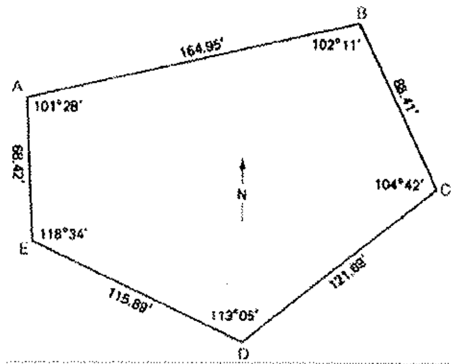
	– ii) Bring the bubble to the centre of its run by turning both foot screws simultaneously in opposite directions either inwards or outwards. The movement of the left thumb indicates the direction of movement of bubble. v) Turn the theodolite through 90 in azimuth so that the plate level becomes perpendicular to the previous position. vi) With the help of third floor screw, move the bubble to the approx. mean position already indicated. – vii) Repeat the process until the bubble, retains the same position for every setting of the instrument. Ellimination of Parallax – **Parallax is a condition arising when the image formed by the objective is not in the plane of the cross hairs** – **Unless parallax is eliminated, accurate sighting is impossible.** – **Focusing the eye-piece :** To focus the eye-piece for distinct visions of the cross-hairs, hold a sheet of white paper in front of objective and move eyepiece in and out till the cross hairs are seen sharp and distinct. **Focusing the objective :** The Telescope is now directed towards the object to be sighted and the focusing screw is turned till the image appears clear and sharp.	2		
2	To measure the angle *PQR* : (1) Set the instrument at *Q* and level it. With the help of upper clamp and tangent screw, set 0^0 reading on vernier *A*. Note the reading of vernier *B*. (2) Loose the lower clamp and direct the telescope towards the point *P*. Clamp the lower clamp and bisect point *P* accurately by lower tangent screw. (3) Unclamp the upper clamp and turn the instrument *clockwise* about the inner axis. Clamp the upper clamp and bisect *R* accurately with the upper tangent screw Note the reading of verniers *A* and *B* to get the approximate value of the angle *PQR*. (4) Unclamp the lower clamp and turn the telescope clockwise to sight *P* again. Bisect *P* accurately by using the lower tangent screw. *It should be noted that the vernier* *readings will not be changed in this operation since the upper plate is clamped* (5) Unclamp the upper clamp, turn the telescope clockwise and sight *R*. Bisect *R* accurately by upper tangent screw. (6) Repeat the process until the angle is repeated the required number of times (usually 3). The average angle with face left will be equal to final reading divided by three. (7) Change face and take three more repetitions *as* described above. Find the average angle with face right, by dividing the final reading by three. (8) The average horizontal angle is then obtained by taking the average of the two angles obtained with face left and face right 			6
3	• Length and direction of each line is generally measured in the field – To balance the traverse and to check the work			

	• Sometimes it is not possible to take all measurements - due to obstacles or because of some over-sight • Such omitted measurements or missing quantities can be calculated by latitudes and departures provided the quantities required are not more than two • Such cases – no check in field work nor can the survey be balanced • All errors propagated throughout the survey are thrown into the computed values of the missing quantities Four general cases of omitted measurements: I. (*a*) When the *bearing* of one side is omitted. (*b*) When the *length* of one side is omitted. (*c*) When the *bearing* and *length* of one side is omitted. II. When the *length* of one side and the *bearing* of another side are omitted. III. When the *lengths* of two sides are omitted. IV. When the *bearings* of two sides are omitted.	2 4		6
4	**Consecutive Co-ordinates:** ◈ Consecutive Co – ordinates of a station is designated by it's departure and latitude from it's previous station as origin ◈ *The latitude and departure of any point with reference to the preceding point are called consecutive co-ordinates of the point* **Independent co-ordinates:** ◈ The co – ordinate of any point with respect to a common origin are known as independent co –ordinates of the point. They are also called the total latitude and total departure of a point ◈ The two reference axes may be chosen to pass through any of the traverse station but generally a most westerly station is chosen for this purpose ◈ x Co ordinate (or total departure) of any point of a traverse = x coordinate of the first point of traverse + algebraic sum of departures of lines between 1st point and that point ◈ y Co ordinate (or total latitude) of any point of a traverse = y coordinate of the first point of traverse + algebraic sum of latitudes of lines between 1st point and that point ◈ x Co ordinate (or total departure) of last point of a traverse = x coordinate of the first point of traverse + algebraic sum of all departures ◈ y Co ordinate (or total latitude) of last point of a traverse = y coordinate of the first point of traverse + algebraic sum of all latitudes ◈ The departure and latitude of a station with reference to a common origin are known as independent coordinates	3 3		6
5	Measurement of vertical angle: ✓ The theodolite is centred and levelled properly. Level the instrument with reference to the plate level ✓ Keep the altitude level parallel to any two foot screws and bring the bubble central. Rotate the telescope through 90^0 till the altitude bubble is on the third screw. Repeat the procedure till the bubble is central in both the positions. If the bubble is in adjustment it will remain central for all pointings of the telescope. ✓ Loose the vertical clamp and rotate the telescope in vertical plane to sight the object. Use vertical circle tangent screw for accurate bisection ✓ Read both the verniers (C and D) of vertical circle. The mean of the two gives the vertical circle reading. Similar observation may be made with another face. The average of the two will give the required angle			6

				
6	Different systems of Tacheometry: ✓ The stadia system ✓ Fixed Hair method or stadia method ✓ Movable Hair method or Subtense method ✓ The tangential system ✓ Measurement by means of special instruments Fixed Hair Method or Stadia Method: • Observations are made with the help of stadia diaphragm having stadia wires at fixed or constant distance apart • The difference in readings corresponding to top and bottom stadia wires will therefore, depend on the distance of the staff from the instrument • When staff intercept is more than the length of the staff,only half intercept is read • For inclined sights – staff either vertical or normal to LOS Subtense Method or Movable hair method: • Similar to fixed hair method, but the stadia interval is variable • Suitable arrangement is made to vary the distance between the stadia hair so as to set them against the two targets on the staff kept at the point under observation. • Thus in this case, the staff intercept, ie, the distance between the two targets is kept fixed while the stadia interval, ie, the distance between the stadia hairs is variable Tangential tacheometry: • In this method, the stadia hairs are not used, the readings being taken against the horizontal cross hair • To measure the staff intercept, two pointings of the telescope necessary • Two vertical angles are required to be measured for one single observation	3 1 1 1		6
7	The components of GPS receiver are • Antennas with preamplifier • RF section with signal identification and signal processing • Microprocessor for receiver control data sampling, data processing • Precision oscillator • Power supply • User interface, command and display panel	1x6		6
	PART C			
III. a	• Transiting: The operations consisting of revolving the telescopethrough 180° in a vertical plane about its horizontal axis • Telescope normal	2x4		8

	A telescope is said to be normal or direct when the face of the vertical circle is to the left and the bubble of the telescope up. • Telescope inverted A telescope is said to be inverted when the face of the vertical circle is to the right and the bubble of the telescope down. • Vertical Axis It is the axis about which the instrument can be rotated in a horizontal Plane .Lower and upper plates rotates about this axis.			
III. b	<u>**Measurement of magnetic bearing of a line**</u> • Theodolite should be provided with either a tubular compass or trough compass • Set the instrument at P and level it accurately • Set accurately the Vernier A to zero • Loose the lower clamp. Release the needle of the compass. Rotate the instrument about its outer axis till the magnetic needle roughly points north. Clamp the lower clamp. Using lower tangent screw, bring the needle exactly against the mark so that it is in magnetic meridian. The line of sight will also be in magnetic meridian • Loose the upper clamp and point the telescope towards point Q. Bisect Q accurately using the upper tangent screw. Read verniers A and B • Change the face and repeat steps 2, 3 and 4. the average of the two will give the correct bearing of the line PQ 	7		7
IV a	<u>The fundamental lines of a transit theodolite are:</u> 1. The vertical axis 2. The horizontal axis (trunnion axis or transit axis) 3. The line of collimation or line of sight 4. Axis of plate level 5. Axis of altitude level 6. Axis of the striding level, if provided <u>The desired Relations are:</u> 1)The axis of the plate level must lie in a plane perpendicular to the vertical axis If this condition exists, the vertical axis will be truly vertical when the bubble is in the centre of its run 2) The line of collimation must be perpendicular to the horizontal axis at its intersection with the vertical axis. Also, if the telescope is external focusing type. the optical axis, the axis of ·the objective slide and the line of collimation must coincide. If this condition exists, the line of sight will generate a vertical plane when the telescope is rotated about the horizontal axis	3 4		7

	3) The horizontal axis must be perpendicular to the vertical axis. If this condition exists, the line of sight will generate a vertical plane when the telescope is plunged 4)*The axis of the altitude level (or telescope level) must be parallel to line of collimation* If this condition exists, the vertical angles will be free from index error due to lack of parallelism *5) The vertical circle vernier must read zero when the line of collimation is horizontal.* If this condition exists, the vertical angles will be free from index error due to displacement of the vernier *6) The axis of the striding level (if provided) must be parallel to the horizontal axis* If this condition exists, the line of sight (if in adjustment) will generate a vertical plane when the telescope is plunged, the bubble of striding level being in the centre of its run			
IV b	The method is known as *'direction method'* or *reiteration method* or *method of series* is suitable for the measurements of the angles of a group having a common vertex point. To measure the angles *AOB*, *BOC*, *COD* etc., by reiteration, (1) Set the instrument over *O* and level it. Set Vernier A to zero and bisect point *A* accurately (2) Loose the upper clamp and turn the telescope clockwise to point *B*. Bisect *B* accurately using the upper **tangent screw. Read both the verniers. The mean of the** vernier readings will give the angles *AOB*. (3) Similarly, bisect successively, C. *D*, etc., thus closing the circle. Read both the verniers at each bisection. **Since the graduated circle remains in a fixed position throughout** the entire process, each included angle is obtained by taking **the difference between two consecutive readings** (4) On final sight to *A*, the reading of the Vernier should be the same as the original setting. If not, note the reading and find the error due to slips etc., and if the error is small, distribute it *equally* to all angles. If large, repeat the procedure and take a fresh set of readings. (5) Repeat steps 2 to **4** with the other face  FIG. 6.10	1 7		8
V. a	Bearing of AB = 10°12' Add <B = 225°13' = 235°25' Subtract = 180° Bearing of BC = 55°25' Add <C = 211° 36' = 267°1' Subtract = 180°	1.5 1.5		8

	Bearing of CD = 87°1′ Add <D = 300°26′ = 387°27′ Subtract = 180° Bearing of DE = 207°27' Add <E = 231°12' = 438°39' Subtract = 180° Bearing of EA = 258°39' Add <A = 291°33' = 550°12' Subtract = 180° = 370°12' Subtract = 360° Bearing of AB = 10°12' Which agrees with the observed bearing of AB and checks the arithmetical work	1.5 1.5 2		
V. b	• That type of survey in which a number of connected survey lines form the frame work is called traversing • The directions and lengths of the survey lines are measured with the help of an angle (or direction) measuring instrument and a tape (or chain) respectively • When the lines form a circuit which ends at the starting point, it is known as a <u>closed traverse.</u> • If the circuit ends elsewhere, it is said to be an <u>open traverse</u> • Closed traverse – suitable for locating the boundaries of lakes, woods, etc • Open traverse – suitable for surveying a long narrow strip of land – road, canal, coast line, etc.  Open Traverse  Closed Traverse **<u>Checks in closed Traverse</u>**	3		7

	• The errors involved in traversing are two kinds: Linear and Angular • For important work the most satisfactory method of checking the linear measurements consists in chaining each survey line a second time, preferably in the reverse direction on different dates and by different parties Checks for angular works: • Traverse by included angles The sum of measured interior angles should be equal to (2n-4)x Right angles, where n= no of sides of the traverse If the exterior angles are measured, their sum should be equal to (2n+4)right angles • Traverse by deflection angles The algebraic sum of the deflection angles should be equal to 360^0, taking right hand deflection angles positive and left hand deflection angles as negative • Traverse by direct observation of bearings The fore bearing of last line should be equal to its back bearing $+180^0$ or -180^0, measured at initial station	4		
VI.a	Traverse computations are usually done in a tabular form, a more common form called Gale's Traverse Table. The computations for a closed traverse may be made in the following steps and entered in a tabular form, which is known as Gale's Traverse Table 1. Sum up all the included angles. Their sum should be equal to (2N+4) right angles for exterior angles and (2N-4) right angles for interior angles, where N is the no.of sides of a traverse. 2. If not apply the necessary corrections to the angles so that the sum of the corrected angles will exactly equal (2N±4) right angles. 3. Calculate the whole circle bearings of the other lines from the observed bearing of the first line and the corrected included angles. 4. From the WCB of the lines, deduce the reduced bearings (RB) of the lines, and determine the quadrants in which the lines lie. 5. From the given lengths and the calculated reduced bearings of the lines, compute their laitudes and departures (Consecutive Coordinates). 6. Add all the northings, and add all southings and find the differences between the two sums. Similarly, obtain the difference between the sum of all eastings and sum of all westings.			8

7. Apply the necessary corrections to the latitudes and departures so that the sum of the northings equals that of southings and the sum of eastings equals that of westings. The corrections may be applied either by transit rule or by compass rule depending upon the type of traverse.
8. From the corrected consecutive coordinates, obtain the independent coordinates of the lines so that they are all positive, the whole of the traverse thus lying in the first quadrant (N.E)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) Consecutive Co-ordinates				(9) Correction				(10) Corrected Consecutive Co-ordinates				(11) Independent Co-ordinates	
Line and Length (m)	Point	Angle	Correction	Corrected Angle	W.C.B	R.B	N	S	E	W	N	S	E	W	N	S	E	W	N	E
	A	95°24'	−6'	95°18'			107.97		3.77		+0.26		−0.01		108.23		3.76		200*	100*
AB 250					86°42'#	N86°42'E														
	B	88°42'	−6'	88°36'			14.39		249.57		+0.03		−0.71		14.42		248.86		214.42	348.85
BC 123					174°06'	S5°54'E														
	C	88°12'	−6'	88°06'				122.94	4.12			−0.29	−0.01			122.65	4.11		91.77	352.96
CD 256					270°00'	N90°W														
	D	88°06'	−6'	88°00'			0			256.00	+0			+0.73	0			256.73	91.77	96.23
DA 108					2°00'	N 2°E														
SUM		360°24'	−24'	360°00'			122.36	122.94	257.46	256.00	+0.29	−0.29	−0.73	+0.73	122.65	122.65	255.73	256.73		
							−0.58		+1.46		+0.58		−1.46		0		0			

Remarks. (1) All interior angles were measured. Bearing of AB was also observed.
(2) The corrections to latitudes and departures have been applied by transit rule.
Note : *assumed, #observed

Sample Gales Traverse Table

VI.b (Marks: 3, 7)

Line	Length	Bearing	Latitude	Departure
PQ	70.80	140°15'	-54.434	45.272
QR	195.90	36°25'	157.645	116.297
RS	35.20	338°45'	32.807	-12.758
			∑L = 136.018	∑ = 148.811

- Latitude of SP = -136.018 m
- Departure of SP = -148.811 m
- tanΘ = D/L= -148.811/-136.018 (4)
- Θ= 47°34'18.09" = S 47°34'18.09" W = 227°34'18.09"
- Length of SP = -136.018 sec(227°34'18.09") = 201.613 m

VII. a (Marks: 7)

ab = i = stadia interval
AB = S = Staff intercept
f = focal length of objective
f1 = horizontal distance of the staff from the optical centre of objective
f2 = horizontal distance of cross hairs from objective
d = distance of vertical axis of instrument from O
D = Horizontal distance of staff from vertical axis of instrument
M = Centre of instrument corresponding to vertical axis

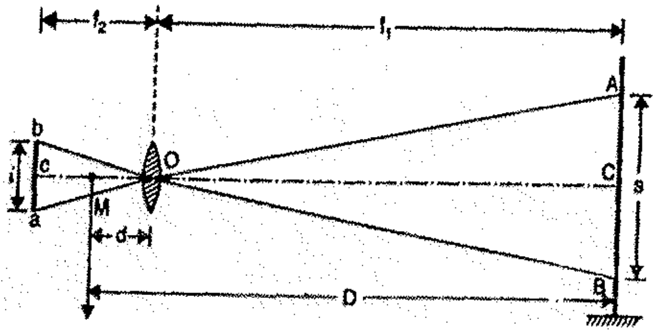
$\frac{f1}{S} = \frac{f2}{i}$ or $\frac{f1}{f2} = \frac{S}{i}$

f1 and f2 are conjugate focal distance, we have from optics

$$\frac{1}{f} = \frac{1}{f1} + \frac{1}{f2}$$

Multiplying throughout by ff_1

f1 = f + $\frac{f1}{f2} X f$

<table>
<tr>
<td></td>
<td>Substituting the value of $\frac{f1}{f2} = \frac{S}{i}$ in the above equation, we get
$f1 = f + \frac{S}{i} f$
Horizontal distance between the axis and the staff is D = f1 + d
$D = f + \frac{S}{i} f + d$
$D = f\frac{S}{i} + f + d$
$K = \frac{f}{i}$ and $c = f + d$
D = KS + C


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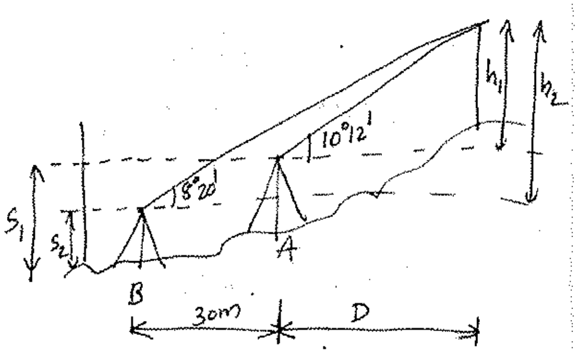
<tr>
<td>VII. b</td>
<td>✓ S1 = 1.578 m
✓ S2 = 1.269m , s= 0.309 m
✓ $\alpha1 = 10^0 12'$, $\alpha2 = 8^0 20'$
✓ $D = \frac{S - b\tan\alpha_2}{\tan\alpha_2 - \tan\alpha_1}$
$= \frac{0.309 - 30\ \tan 8^0 20'}{\tan 8^0 20' - \tan 10^0 12'}$
$= \frac{0.309 - 4.394}{0.1465 - 0.1799}$
$= \frac{-4.0854}{-0.0335} = 122.13$ m
✓ h1 = D tanα1
= 122.13 tan(10⁰12′) = 21.97 m
✓ RL of top of Chimney = RL of BM + S1 +h1
= 543.075 +1.578 + 21.97 = 566.623m
Check:
h2 = (b + D) tanα2
=(30+122.13) tan($8^0 20'$) = 22.28 m
RL of top of chimney = RL of BM + S2 +h2
= 543.075 +1.269 + 22.28 = 566.63 m


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<tr>
<td>VIII a</td>
<td>• Additional convex lens placed between the diaphragm (Eye piece) and the objective glass at a fixed distance from the objective, inside the telescope.
• Function is to reduce the stadia constant (C) to zero
• By providing anallatic lens, the vertex is formed at the vertical axis and its position is always fixed irrespective of staff position.</td>
<td>3</td>
<td></td>
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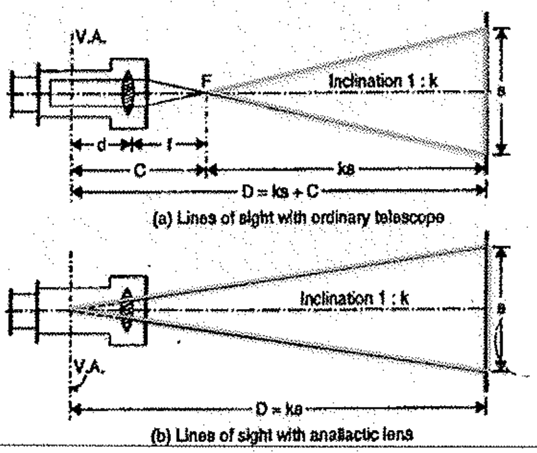
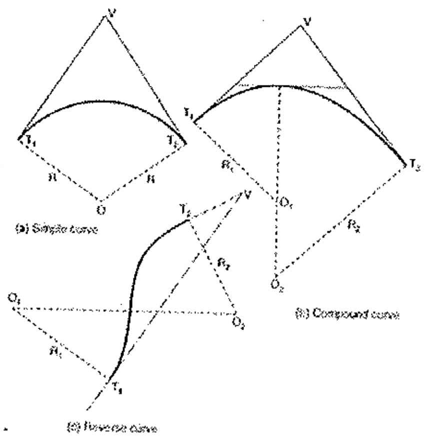
	• Anallactic lens is provided in external focusing type telescopes only. Advantages: o Due to annalatic lens the additive constant vanishes and the computations are made quicker o As a rule, the annalatic lens is sealed against moisture and dust. The loss of light may be compensated by use of slightly larger object glass Disadvantages o The annalatic lens absorbs much of incident light o The annalatic lens cannot be easily cleaned o If the annalatic lens is adjustable, it is a potential source of error unless proper field check is made from time to time  (a) Lines of sight with ordinary telescope (b) Lines of sight with anallactic lens	2 2		
VIII b	• Height of vane above inst. Axis = D tan α = 2000 tan $9^0 30'$ = 334.68 m • Correction for curvature and refraction = 0.0678 D^2 = + 0.27 m • Height of vane above inst. Axis = 334.68 +0.27 = 334.95 m • RL of Vane = 2650.38 +334.95 = 2985.33 m • RL of Q = 2985.33 - 4 = 2981.33 m • Correction can be applied at the end also.	2 2 2 1 1		8
IX a	Horizontal Curves: • Curves are generally used on highways and railways where it is necessary to change direction of motion • Changes in direction cannot be sharp, but have to be gradual, which necessitates the introduction of curves in between straights • A curve may be circular, parabolic or spiral and is always tangential to the two straight directions 1. Simple Curves • The curve which consists of a single arc of a circle • It is tangential to both the straight lines	1 3		8



2. Compound Curves
- Consists of two or more simple arcs that turn in the same direction and join at common tangent points

3. Reverse Curves
- One which consists of two circular arcs of same or different radii, having their centres to the different sides of the common tangent
- Both the arcs thus bend in different directions with common tangent at junction

2

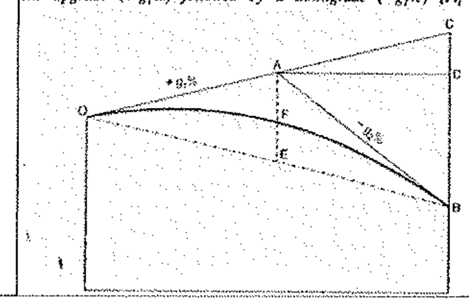
2

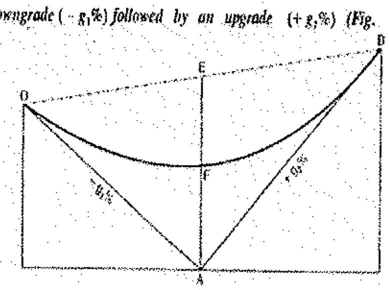
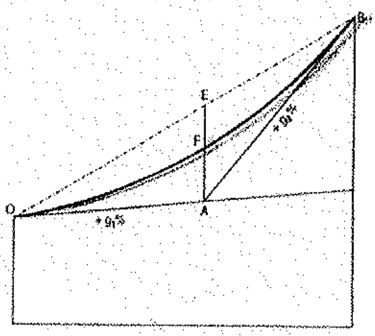
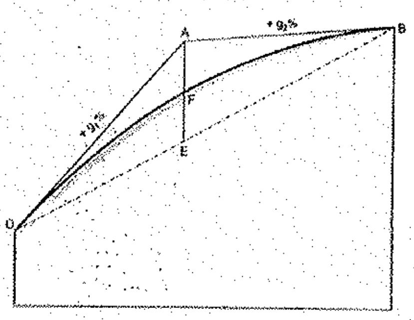
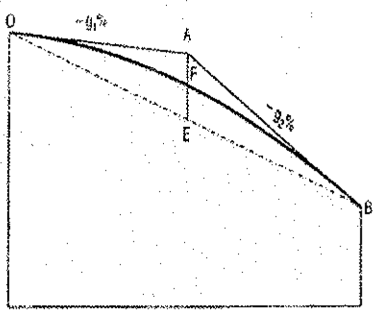
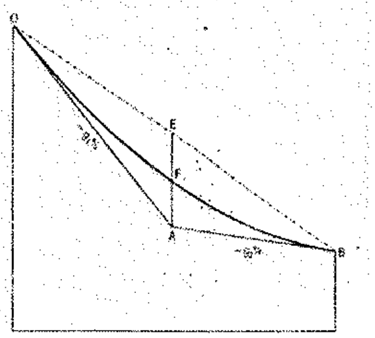
Transition Curves:
A transition curve or easement curve is a curve of varying radius introduced between a straight and a circular curve, or between two branches of a compound curve or reverse curve. When a straight section changes into a curve, the radius varies gradually from infinite to finite value.

Vertical Curves:
- A vertical curve is used to join two intersecting grade lines of railroads, highways or other routes to smooth out the changes in vertical motion
- Ridges – A rising gradient is followed upto the highest point and then falling gradient
- Valley – A falling gradient first and then a rising gradient

Types of Vertical Curves:

An upgrade $(+g_1\%)$ followed by a downgrade $(-g_2\%)$ (Fi



	A downgrade ($-g_1$%) followed by an upgrade ($+g_2$%) (Fig.  *An upgrade ($+g_1$%) followed by another upgrade ($+g_2$%) $g_2 > g_1$*  *(4) An upgrade ($+g_1$%) followed by another upgrade ($+g_2$%) $g_1 > g_2$*  *(5) A downgrade ($-g_1$%) followed by another downgrade ($-g_2$%) : $g_2 > g_1$*  *(6) A downgrade ($-g_1$%) followed by another downgrade ($-g_2$%) : $g_1 > g_2$*  			
IX b	1. To give average angles and measurements electronically 2. To adjust the measurements from the pressure of climate and temperature changes 3. To find the heights in trigonometric leveling 4. To correct the defects due to curvature and refraction 5. Changing the inclined lengths to horizontal lengths 6. To find the vertical heights directly 7. To measure the area with single station 8. Orientation by resection methods 9. Making the centre line for typical residential building 10. Longitudinal section and cross sections for proposed road canal or pipe line.			7
X a	Remote sensing may be defined as art and science of gathering the information about objects, occurrence or area without having physical contact with it. **<u>Passive and active remote sensing</u>** On the basis of source of energy used by the sensors, they can be classified into two types: Active sensors and Passive sensors **PASSIVE REMOTE SENSING** The sun provides a very convenient source of energy for remote sensing. • For all	3		7

	reflected energy, this can only take place during the time when the sun is illuminating the Earth. • Energy that is naturally emitted can be detected day or night, as long as the amount of energy is large enough to be recorded **ACTIVE REMOTE SENSING** Active sensors provides their own energy source for illumination. • The sensor emits radiation which is directed toward the target to be investigated. The radiation reflected from that target is detected and measured by the sensor. • Advantages for active sensors include the ability to obtain measurements anytime, regardless of the time of day or season. **<u>Applications</u>** 1. Agriculture • Command area management • Detection of crop violation • Zoom cultivation – Desertification • Early season estimation of total cropped area • Monitoring crop condition using crop growth profile • Crop yield modelling Forestry • Improved forest type mapping • Monitoring large scale deforestation • Forest stock mapping • Wild life habitat assessment • Monitoring urban forestry 2. Landuse and Soils • Landuse/ Landcover mapping • Soil categorization • Change detection • Identification of degraded lands Water resources • Monitoring surface water bodies frequently and estimation of their spatial extent • Glacier inventory Coastal Environment • More detailed inventory of coastal landuse • Monitoring sediment dynamics • Discrimination of coastal vegetation types 3. Geology • Mineral exploration • Oil field detection • Geomorphological mapping • Drainage analysis • Groundwater exploration 4. Urban landuse • Urban landuse mapping • Updating of urban transport network • Monitoring urban sprawl • Identification of unauthorized structures 5. Environment • Impact assessment on vegetation, waterbodies • Siting applications • Loss of biological diversity/ Wetland environment Watershed • Delineation of watershed boundaries • Watershed characterization at large scale (size, shape, drainage, landuse/landcover) • Siting of water harvesting structures • Monitoring watershed development • Major river valley projects 6. Disaster • Mapping flood inundated area, Damage assessment • Disaster warning mitigation Digital Elevation Models • Contours (>10 m) • Slope analysis • Large scale thematic mapping upto 1: 25,000 scale Ocean resources • Low tide/ high tide marking • Potential fishing zone • Wealth of oceans, productivity 7. Facilities management • Locating underground pipes, cables • Balancing loads in electrical network • Tracking energy use Natural resources based applications • Wildlife analysis, migration routes planning • Ground water modelling • Management of wild and scenic rivers, recreation resources, wetlands, aquifers, agricultural lands, forest, wildlife, etc,. Street network based application • Vehicle routing and scheduling • Location analysis – site selection – evacuation plans 8. Land based application • Zoning, subdivision plan review • Land acquisition • Environmental management • Water quality management • Maintenance of ownership	4		
X b	• Back Tangent The tangent previous to the curve is called the back tangent or first tangent (AT1) • Forward Tangent The tangent, following the curve is called the forward tangent or second tangent (T2B) • Point of Curve (PC) or Point of Commencement It is the beginning of the curve where the alignment changes from a tangent to a curve	4x2		8

	• Point of Tangency (PT) It is the end of the curve where the alignment changes from a curve to tangent