WINTER– 18 EXAMINATION
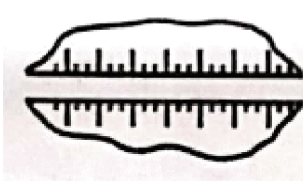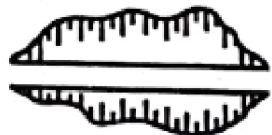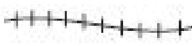
Subject Name: Surveying   <u>Model Answer</u>   Subject Code: **17310**

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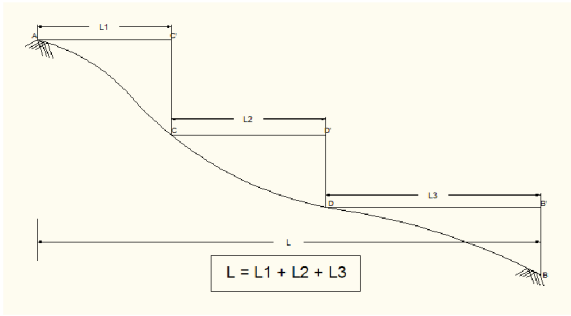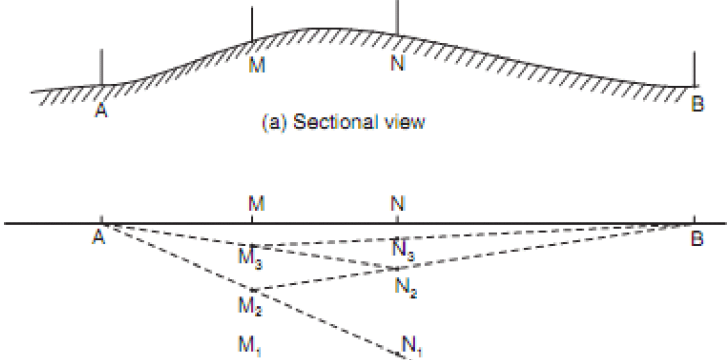7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	A)	**Attempt any <u>SIX</u>**	**(12)**

Q.1	A) (a) Ans.	**State the principles of surveying.**
		Main principles of surveying are:
		   1) To work from whole to part.
		   2) To locate a point at least by two independent processes
			(01 Mark)
			(01 Mark)

Q.1	A) (b) Ans.	**Define plane and geodetic survey.** **Plane Surveying** Plane surveying is that type of surveying which does not take into account the curvature of the earth, and the surface of the earth is treated as plane surface. **Geodetic Surveying** The geodetic surveying is that type of surveying which takes into account the curvature of earth's surface.	(01 Mark) (01 Mark)
Q.1	A) (c) Ans.	**Enlist the different instrument used for linear measurement.** Following are the instruments used for linear measurement. i) Chain ii) Tape iiii) Plumb bob. iv) Ranging rods and poles. v) Pegs. vi) Arrows or taping pins. vii) Spirit level. viii) Line ranger.	(02 Marks for any four)
Q.1	A) (d) Ans.	**State the principle of compass survey.** The principle of compass survey is traversing, which involves a series of connected survey lines (may be open or closed) whose lengths and bearing are measured by linear and angular measuring instruments.	(02 Marks)

Q.1	A) (e) Ans.	**Define: i) Open traverse ii) Closed traverse.** **Open traverse**: A traverse is said to be open traverse when it does not form a close polygon. Start and end point of this traverse are different. **Closed traverse** A traverse is said to be closed traverse when it does form a close polygon. Start and end point of this traverse are same.	(01 Mark) (01 Mark)
Q.1	A) (f) Ans.	**Enlist the accessories used in plane tabling.** **Accessories used in plane tabling.** 1. The table or board mounted on a tripod and 2. A straight edge called the 'alidade' 3. A trough compass 4. U Fork 5. A spirit level 6. A Water-proof cover 7. Drawing paper 8. Other drawing materials required: pins, pencil, eraser, scales etc.	(02 Marks for any four)
Q.1	A) (g) Ans.	**State the objective of leveling.** Following are the objective of leveling i) To find the elevations of given points with respect to some assumed reference line called Datum. ii) To establish points at required elevation with respect to datum.	(01 Mark) (01 Mark)
Q.1	A)(h) Ans.	**Define : i) Datum ii) Change point** **i) Datum** It is an arbitrary level surface (line) from which elevation of points may be referred. In India, mean sea level at Karachi is considered as datum. **ii) Change point** It is point on which fore and back sights are taken.	(01 Mark) (01 Mark)
Q.1.	B)	**Attempt any TWO**	08 Marks
Q.1	B) (a) Ans.	**Draw conventional symbol for** **i) Embankment ii) Cutting iii) Single railway line iv) Marshy land** **Embankment** Cutting Railway line: Single Marshy land	(01 Mark each)

		Marshy land	
Q.1	B)(b)	State the classification of survey based on: i) the nature of the field of survey ii) the object of survey	
	Ans.	Classification of survey based on the nature of the field of survey a) Land Survey 　　i) Topographical Survey 　　ii) Cadastral Survey 　　iii) Engineering Survey b) Astronomical Survey c) Marine Survey	(02 Marks)
		Classification of survey based on the object of survey a) Engineering Survey b) Geological Survey: c) Military Survey d) Archaeological Survey e) Mine Survey	(02 Marks)
Q.1	B)(c) Ans.	Define ranging. State any four codes of signals in ranging. **Definition** The method of establishing intermediate points on a straight line between the two fixed points is known as ranging.	(02 Mark)

Code of Signals for Ranging:

Sr. No.	Signal by the Surveyor	Action by the Assistant
1.	Rapid sweeps i.e. up and down movement with right hand on right side.	Move considerably to the right.
2.	Rapid sweeps i.e. up and down movement with left hand on left side.	Move considerably to the left.
3.	Slow sweeps with right hand on right side.	Move slowly to the right.
4.	Slow sweeps with left hand on left side.	Move slowly to the left.
5.	Right arm extended.	Continue to move to the right.
6.	Left arm extended.	Continue to move to the left.
7.	Right arm up and moved towards right.	Make the rod vertical by moving towards right.
8.	Right arm up and moved towards left.	Make the rod vertical by moving towards left.
9.	Both hands above the head and brought down.	Correct.
10.	Both arms extended forward horizontally and then depressed.	Fix the ranging rod.

(02 Marks for any four points)

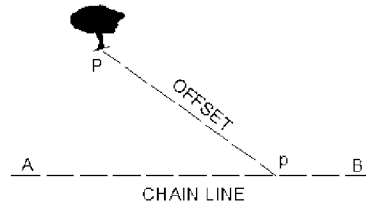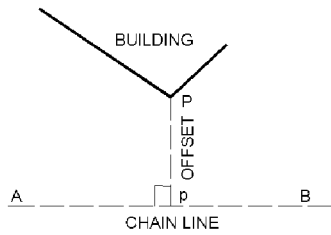| Q.2		**Attempt any FOUR**	(16)

| Q.2	a) Ans.	**Explain procedure of chaining on sloping ground.** In direct method which is also known as stepping method horizontal distance is directly measured as shown in fig. **Stepping Method** Horizontal distance between A and B is required to be measured. Procedure: i) A portion of tape say 2 to 4m is stretched horizontally with one end resting on ground and other end held horizontally at convenient height. ii) The point vertically below the other end is transferred on the ground with the help of plumb bob (Say C). iii) The next step start from the C and the method is continued till point B reached.	(01 Mark) (03 Marks)
Q.2	b) Ans.	**Explain the procedure of indirect ranging.** Let A and B be two survey stations. They are not mutually visible due to high ground between them. Let two assistant stands at M1 and N1 as shown in fig. The assistant at M1 can see both the ranging rods at N1 and B, and assistant at N1 can see the ranging rod M1 and A. Now assistant at M1 direct N1 in line BM1, N2 be the new position of N1 on line M1B. The assistant on N2 direct the M1 on line N2A and M2 be the new position of M1.M2 and N2 be the new position of M1 and N1 which are nearer to line AB. Repeat same process until points M and N are established.	(02 Marks) (02 Marks)

Q.2	c)
	
	Ans:
		Length of survey line measured with 30 m chain was found to be 1230 m. When the chain was compare with standard chain, it was found to be 0.35 m too short. Find correct length of the line.
		Given Data:
		    L = 30 m
		    Measured Length = 1230 m
		    Error = -0.35 m	

		L' = 30 -0.35 = **29.65 m** Solution: Correct Distance = (L'/L) x Measured Length = (29.65/30) x 1230 = **1215.65**	**(01 Mark)** **(01 Mark)** **(02 Marks)**
Q.2	**d)** **Ans.**	**Define : i) Survey line ii) Base line iii) Check line iv) Tie line** **i) Survey line** Main stations are the ends of chain line which command the boundaries of the survey. Line joining main stations is called main survey lines **ii) Base line:** Base line is generally the longest line running roughly through the middle of the area. It is laid on a level ground as far as possible. The whole frame work is built upon this line. **iii) Check line** It is a line joining apex of triangle to some fixed point on the opposite side or a line joining some fixed point on any two sides of the triangle. **iv) Tie line** It is a line joining some fixed points as tie stations on the main chain lines. It enables surveyor to locate the interior details.	**(01 Mark)** **(01 Mark)** **(01 Mark)** **(01 Mark)**
Q.2	**e)** **Ans.**	**Explain principle of optical square with neat sketch.** The optical square is an instrument used to set perpendicular offset on the chain line. The optical square works on the principle of optics. Principle of optical square: The angle between the incident ray and reflected ray is twice the angle between mirrors. 	**(02 Marks)** **(02 Marks)**
Q.2	**f)** **Ans.**	**Explain the types of offset with neat sketch.** When the measurements are taken at right angles (90º) to the chain line, they are known as "perpendicular offsets". When the measurements are taken at angle other than 90º, they are called as "oblique offset".	**(01 Mark)** **(01 Mark)**

(01 Mark)

When the length of offset is equal to 15 m or less than 15 m then the offset is known as short offset.

Offsets having length more than 15 m then the offset is known as long offset.
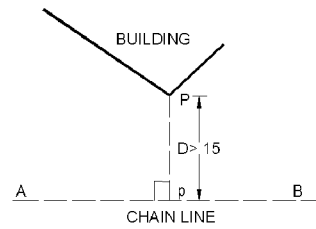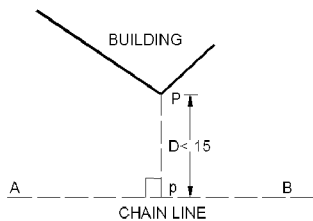
(01 Mark)

Q.3		Attempt any FOUR of the following:	(16)
Q.3	a)	**Suggest the method to overcome an obstacle in chaining, where vision is clear but chaining obstructed.**	
	Ans:	There are two cases or method to overcome an obstacle in chaining, where vision is clear but chaining obstructed.	

Case (i) (a) When the obstacle can be chained around.

Let PQ be the obstructed length. Erect perpendicular at P and Q so that PR = QS, measure the length RS which is equal to PQ.

(b) Erect perpendicular PR as shown in the Fig.2.14 (b) RQ line clears the obstacle. Then PQ = root of $RQ^2 - PR^2$

1M

(c) By optical square or cross staff set 90^0 angle at R as shown in fig. 2.14 (c). Then PQ = square root of $PR^2 + RQ^2$.
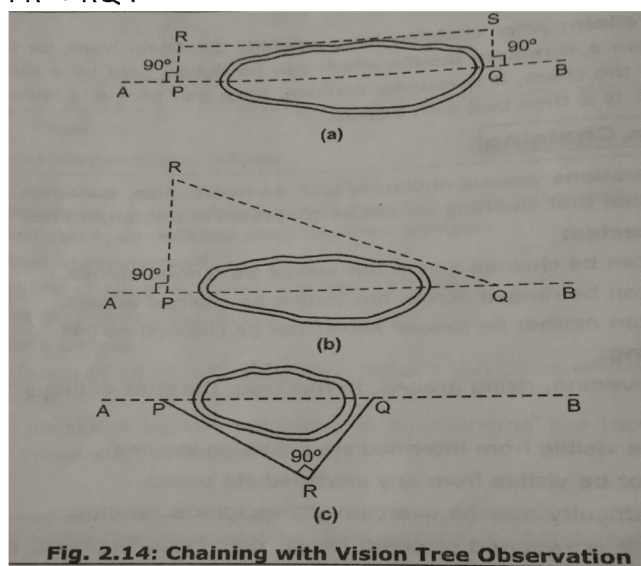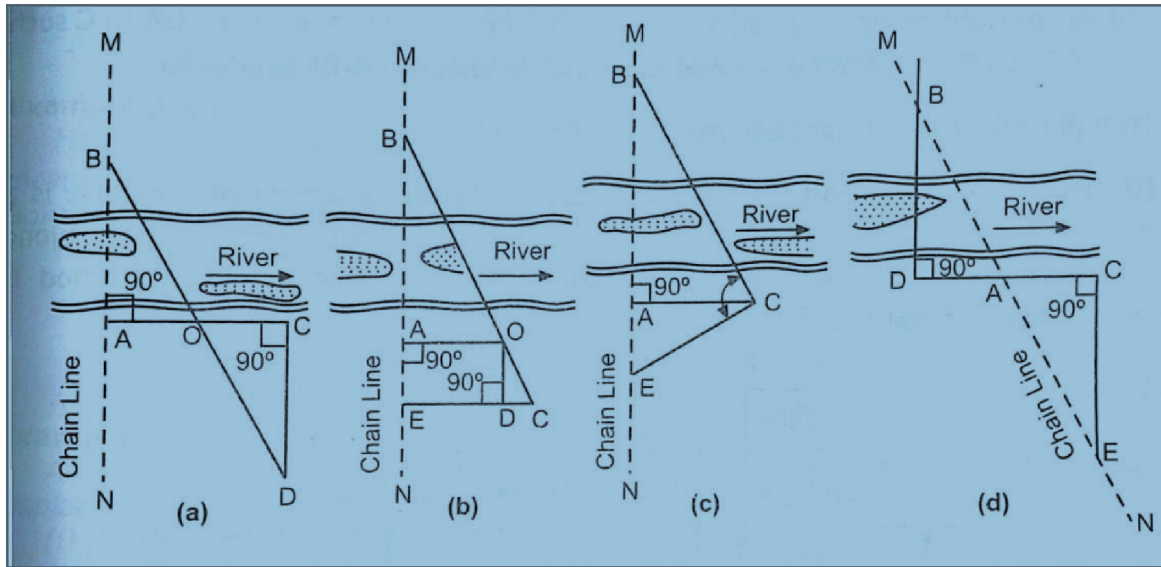

Fig. 2.14: Chaining with Vision Tree Observation

1M

Case (ii) When it is not possible to chain round the obstacle.

1M

Fig-a) A & B are two points on opposite banks of river as shown in fig 1. obstructed length is AB on the chain line MN , Set AC perpendicular to AB & bisect at O . Errect perpendicular at C & mark a point D in a line with BO , measure the length CD , from principle of similar triangles ABO & CDO, AB = CD

OR

Fig.c) In fig 2, A & B are two points on either side of the river, set out perpendicular AC at A of sufficient length. Erect perpendicular CE at C , measure the length AC & AE

Triangles ABC & ACE are similar Triangles

AB/AC = AC/AE

$AB = (AC)^2 /AE$

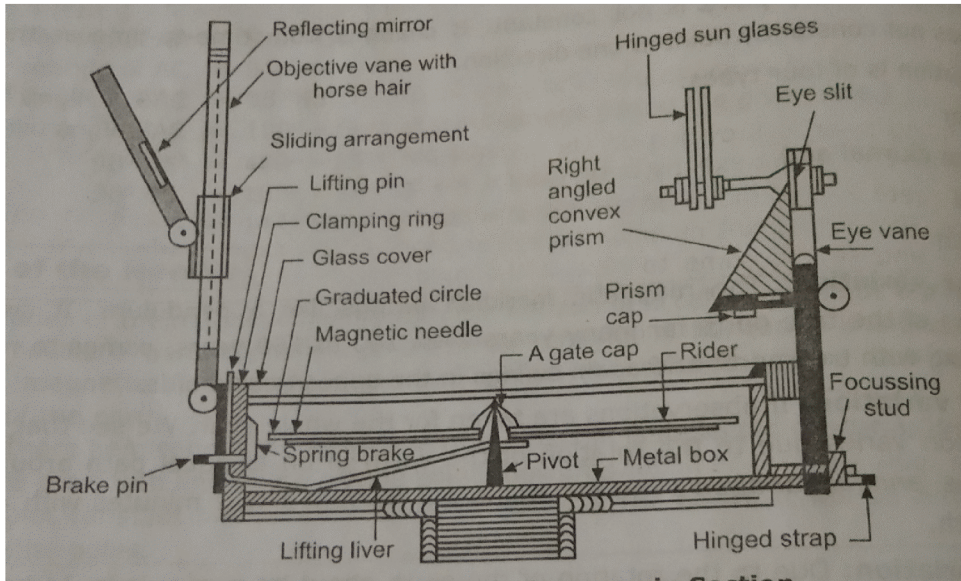**(Note- If the students write explanation on similar lines for fig. b & d credit may be given)**

1M
(For
any
one
expl.)

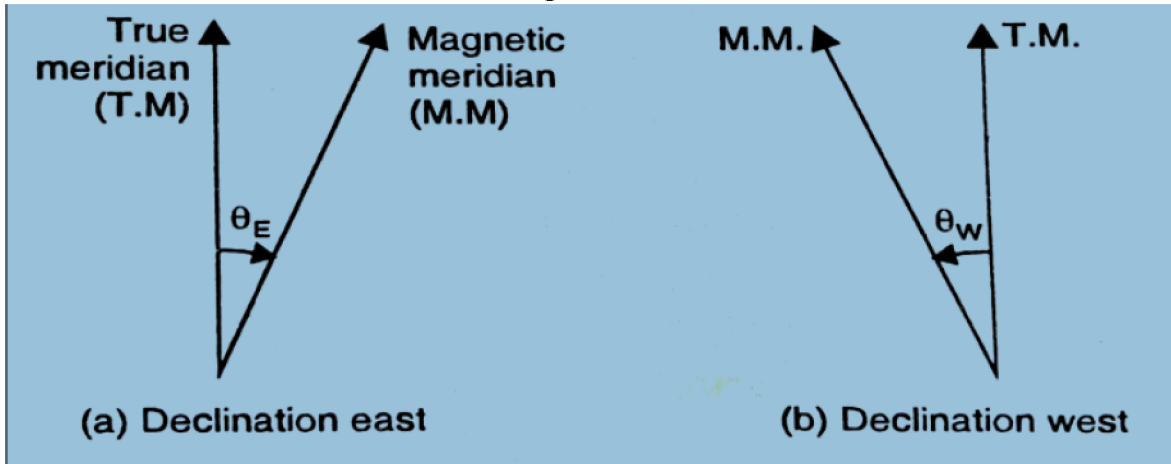| Q.3	(b) Ans.	**Draw a labelled sketch of Prismatic Compass.** 	04 M
Q.3	(c) Ans:	**Explain the term 'magnetic declination'.** The horizontal angle between the magnetic meridian and true meridian is known as magnetic declination. When magnetic north gets deviated from true north towards east or west due to local attraction, then it is known as magnetic declination. Due to various local sources magnetic needle of prismatic compass does not remains in true north position; such an error is called as declination of magnetic needle. Depending upon declination towards east or west direction, there are two types of declinations. i) East declination ii) West declination.	03 M 1 M

Q.3	(d)
	
	Ans:
		Convert following whole circle bearing into R.B.
		(i) 330^0 30' (ii) $45'$ 0" (iii) 149^0 30' (iv) 227^0 30'
		(i) W.C.B = 330^0 30'
		  R.B = 360^0 - 330^0 30'
		  R.B = N 29^0 30' W
		
		(ii) W.C.B = $45'$ 0"
			1 M
			
			1 M

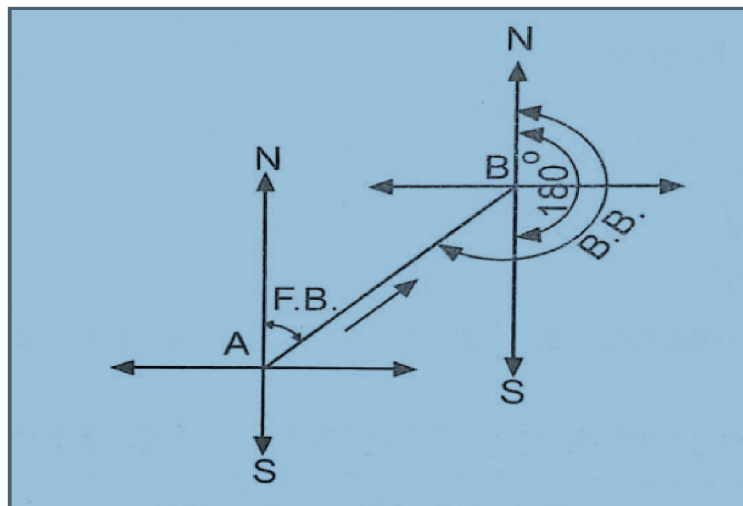|			

		R.B = N $45^{'} 0^{''}$ E
		(iii) W.C.B = $149^{0} 30'$
		    R.B = 180^{0} – W.C.B
		    R.B = 180^{0} - $149^{0} 30'$
		       R.B = S $30^{0} 30'$ E
		
		(iv) W.C.B = $227^{0} 30^{'}$
		    R.B = W.C.B - 180^{0}
		    R.B = $227^{0} 30^{'}$- 180^{0}
		       R.B = S $47^{0} 30^{'}$ W
			1 M
			
			1 M

Q.3	(e) Ans:	**Explain fore bearing and back bearing and their relationship with sketch.** **Fore bearing** : The bearing of line observed in the direction of progress of survey is called fore bearing of the line. Bearing of line AB is observed at 'A' towards 'B' is called as fore bearing of the line 'AB ' **Back bearing** : The bearing of line observed in opposite direction of the progress of survey is called back bearing of the line. The bearing observed at 'B' towards 'A' is called as back bearing of the line 'AB ' Relationship between fore bearing and back bearing : Back bearing $-$ Fore bearing = 180^{0}	1 M 1 M 1 M 1 M
Q.3	(f) Ans:	**The fore bearing of line AB is $111^{0} 30'$ and angle ABC is $105^{0} 15^{'}$. Find bearing of line BC.** CASE-1 FB of line AB = 111°30$^{'}$ BB of AB = FB of line AB + 180° = 111°30$'$+ 180° = 291°30$'$ FB of BC = BB of AB + <ABC = 291°30$'$+ 105°15$'$ = 396°45$'$ But bearing is greater than 360°	 1 M 1 M 1 M

Therefore, FB of BC = 396°45'- 360^0 **FB of BC = 36°45'**	1 M
	OR
OR **CASE-2** FB of line AB = 111°30'	1 M
BB of AB = FB of line AB + 180° = 111°30'+ 180°	1 M
= 291°30' <ABC = BB of AB - FB of BC	1 M
105°15' = 291°30' - FB of BC **FB of BC = 186°15'**	1 M

Q.4		**Attempt any FOUR of the following.**	**(16)**
Q.4	a)	**Calculate the interior angles of closed traverse ABCD with the help of bearing.**	

Line	AB	BC	CD	DA
Bearing	N 45^0 10' E	S 60^0 40' E	S 9^0 50' W	N 80^0 40' W

Ans:

Line	FB (RB)	FB (WCB)	BB (WCB)
AB	N 45^0 10' E	45^0 10'	225^0 10'
BC	S 60^0 40' E	119^0 20'	299^0 20'
CD	S 9^0 50' W	189^0 50'	9^0 50'
DA	N 80^0 40' W	279^0 20'	99^0 20'

Interior angle A = BB of line DA – FB of line AB
Interior angle A = 99°20' - 45°10'
Interior angle A = 54°10'
Interior angle B = BB of line AB – FB of line BC
Interior angle B = 225°10' - 119°20'
Interior angle B = 105°50'   1 M
Interior angle C = BB of line BC – FB of line CD
Interior angle C = 299°20' - 189°50'
Interior angle C = 109°30'
Interior angle D = BB of line CD – FB of line CD   1 M
Interior angle D = 9°50' - 279°20'
Interior angle D = -269°30' (It is exterior angle)
Interior angle D = 360° - 269°30'   1 M
Interior angle D = 90°30'
Sum of all included angle = (2N-4) X 90
= (2X4 – 4)X 90

		= 360° Sum of Calculated interior angle = 54°10'+105°50'+109°30'+ 90°30' Sum of Calculated interior angle = 360°	**1 M**
Q.4	b) Ans:	**Explain the magnetic meridian method of orientation of plane table.** **Magnetic meridian method of orientation-** 1.The trough compass is placed on the top right corner of the plane table in such a way that magnetic needle point exactly towards the N-S direction 2. Draw this line along the edge of compass. 3. Shift & set up the plane table on next station. 4. Place the trough compass along the N-S line. Rotate the table till the magnetic needle coincides the N-S line drawn previously.	**4 M**
Q.4	(c)Ans :	**State two merits and demerits of plane table survey.** **Merits of plane table surveying-** 1. It is most rapid method and suitable for small scale. 2. There is no need of field book. 3. Irregular objects may be represented properly. 4. It is suitable in magnetic area. 5. The surveyor can compare the plotted work with the actual features of the area. 6. It is less costly. 7. No greater skill is required to prepare map. **Demerits of plane table surveying** 1. The plane table survey is not possible in unfavourable climates such as rain, fog etc. 2. This method of survey is not very accurate and thus unsuitable for large scale or precise work. 3. As no field book is maintained, plotting at different scale require full exercise. 4. The method requires large amount of time to be spent in the field. 5. Quality of the final map depends largely on the drafting capability of the surveyor. 6. This method is effective in relatively open country where stations can be sighted easily.	**2 M(for two points)** **2 M(for two points)**
Q.4	(d)Ans:	**Explain the intersection method of plane table survey with neat sketch.** Intersection method of plane tabling- 1. Lay out a base line AB and measure it and Plot a distance 'ab' on sheet using any scale. 2.Set up instrument at 'A' with 'a' over 'A' 3.Orient the table by placing alidade 'ab' and turn table until ranging rod at 'B' is bisected and clamp it. 4. With alidade touching point 'a' draw rays ab, ad, ag, af, ac of indefinite length as shown in figure below. 5. The table is then moved to station 'B' orient by back sighting on 'A' say ray ba. Draw rays towards points previously sighted rays bd, bg, bf, bc are drawn to determine points intersection, d, g, f, c.	**3 M**

1 M
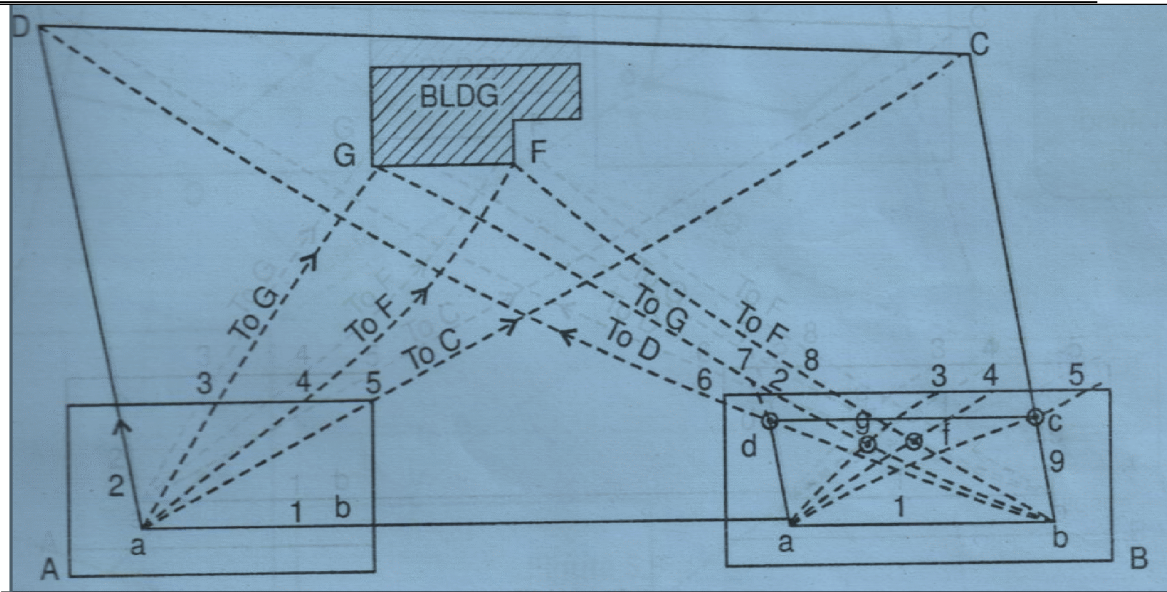
Q.4	(e) Ans:	**Explain the error in plane table survey.**	
		i) The board not being horizontal- This error affects chiefly the measurement of vertical angles.	
		ii) The table not being accurately cantered. The plotted position of the occupied station not being exactly over the station on the ground.	01M each (any four)
		iii) The table not being correctly oriented. To prevent this error, the orientation of the table should be checked at as many stations as possible by back sighting or by magnetic meridian.	
		iv) The table being displaced from its initial position. There is likely to be slight rotation or other displacement of the table. Frequent check-sight should be taken to detect and correct any displacement.	
		v) The defective sighting- The object not being correctly sighted.	

Q.4	(f) Ans :	**Differentiate between H.I. method and rise and fall method on any four points.**		

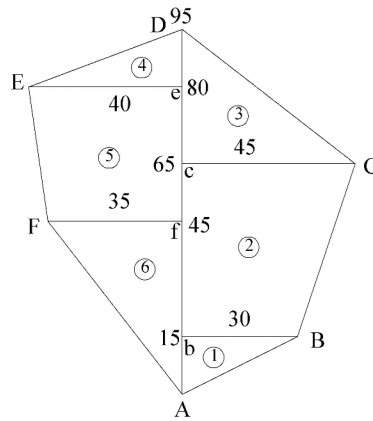| Sr.No	H.I. Method	Rise and Fall Method	
1	It is more rapid and less tedious	It is slow and more tedious.	(Any four points 1 mark each)
2	It is simple as it involves less calculations.	It is laborious as it involves more calculations.	
3	In this method there is no check on calculations of R.L. of intermediate sight and mistakes made remain unchecked	In this method there is complete check on all calculation work.	
4	In this method the error in calculating the R,L, of I.S. is not carried forward as the R,L, are calculated from the respective plane of collimation	In this method the mistake made in calculating the R.L. of any point will be carried forward.	
5	It is usually used in profile levelling calculation.	It is used in precise levelling work,	

				check levelling calculations.	
		6	Arithmetical check ΣB.S.-ΣF.S=Last RL-First RL	Arithmetical check ΣB.S.-ΣF.S= ΣRise–Σfall =Last RL-First RL	

Q.5		**Attempt any FOUR**			**(16)**
	a. Ans.	**State fundamental lines of dumpy level and give their relationship when the instrument is in perfect adjustment.** There are four fundamental axes of a dumpy level. 　1. The vertical axis. 　2. The axis of the bubble tube (Level tube). 　3. The line of collimation. 　4. The axis of the telescope. Desired relations in dumpy level. 　For a dumpy level in perfect adjustment, the following relations should exist. 　1. The axis of the level tube should be perpendicular to the vertical axis. 　2. The line of collimation should be parallel to the axis of the bubble (level) tube. 　3. Axis of telescope and line of collimation should coincide.			02 M 02 M
Q.5	b. Ans.	**State methods of leveling. Explain fly leveling and check leveling.** Various methods of leveling are- 　i.　Simple leveling. 　ii.　Differential leveling. 　iii.　Check leveling. 　iv.　Fly leveling. 　v.　Profile leveling. 　vi.　Cross sectioning. 　vii.　Reciprocal leveling. 　viii.　Trigonometrical leveling. **Fly leveling**: It is the process of leveling to determine the elevation of the point which is some distance apart. It is used to establish bench mark. A series of level is taken from one B. M. to the other. It is also known as differential leveling or compound leveling. **Check leveling**: It is process of running a series of levels to check the levels of T. B. M. with the B. M. At the end of day's work, levels are taken, returning to the starting point on that day say B. M. with a view to check the day's work. If the leveling line closes on itself or on a benchmark of known elevation, it is called as a 'Good check'. In this, an error at an intermediate point cannot be carried forward even if it does not check any reading on a intermediate point.			Any four 1/2 M for each 01 M 01 M
Q.5	c.	**State the advantages of auto level over dumpy level.**			

	Ans.	The advantages of auto level:
		The following are the advantages of Auto level over dumpy level.
		  1. Operational comfort: Use of Auto level is not fatiguing. There is no strain on eyes, nerves and hands of the observer. It does not require any protection from sun.
		  2. High precision: Mean elevation error on invar staff with a least count of 5 mm varies from ±0.5 to 0.8 mm in one km for forward and backward leveling.
		  3. High speed: Time required for leveling is 50% of that required with dumpy level.
		  4. Freedom from error: Due to erect telescope image, the leveling staves are read with erect figures. In automatic leveling there is no possibility of forgetting to centre the bubble.
		  5. Freedom from external influences: The external influences like rain, clouds, magnetic fields, vibrations have no influence on the leveling work.
		  6. Range of application: The level can be used for medium and large size projects. It can also be used for getting bench mark accurately established.
			Any four 01 M for each

Q.5	**d.**
	Ans.
		Explain the various sources of errors occurring during the process of leveling.
		The errors in leveling are due to the following principal sources.
		  1. Instrumental errors
		  2. Personal errors
		  3. Errors due to natural causes
		  1. **Instrumental errors**:
		  i. Error due to imperfect permanent adjustment: When the instrument is not in perfect permanent adjustment, the line of collimation may be inclined upward or downward causing serious errors. The line of collimation may not be parallel to the axis of bubble tube. Axis of telescope may not be perfectly perpendicular to vertical axis. These instrumental errors lead to errors in leveling.
		  ii. Less sensitivity of bubble or bubble is sluggish: If the bubble is not sensitive or it is sluggish, it may apparently be in the center though the bubble line is not horizontal.
		  iii. Faulty focusing tube: Sometimes the focusing tube is faulty. Due to this the objective does not move in horizontal plane but moves in inclined direction during focusing. This is compensatory error and can be eliminated by balancing back sight and fore sight.
		  iv. Errors in leveling staff: The graduations of the leveling staff may not be perfect. These errors can be neglected for ordinary work.
		  2. **Personal errors**:
		  i. Errors of manipulation: (a) Careless leveling of the instrument (b) The bubble not being exactly in centre while sighting. (c) Resting the hand on tripod legs while taking readings. (d) The staff not being held exactly vertical.
		  ii. Imperfect sighting: The error is caused due to poor focusing of eye piece and object glass. The reading are taken without removing parallax.
		  iii. Error due to settlement of staff and level: The level, staff or change point settles if proper precautions are not taken and cause cumulative errors and may be very serious. This can be avoided by planting the instrument on firm ground and proper selection of change point.
		  3. **Errors due to natural causes:**
			01 M
			
			01 M
			
			01 M
			
			01 M

		These are the errors caused due to: (a) Curvature of earth (b) Refraction and (c) Effect of wind and sun on the level.	
Q.5	e. Ans.	**Explain the purpose of taking change point in leveling operation.** Purpose of change point in leveling- During the process of leveling, sometimes taking staff reading at some points which are at too higher or too lower elevation than the height of instrument. In such circumstances with respect to the last staff position, the instrument is shifted to new position and leveling is continued. The staff may be at a place which is beyond the visual range of telescope and readings are not clear. In this situation one needs to take change point. If there is an obstruction to vision from the instrument set up due to high ground, trees and bushes, then change point needs to be taken to continue the leveling operation.	04 M
Q.5	f. Ans.	**Find the height of roof ceiling from floor, if RL of floor is 100.00 m and inverted staff reading at roof ceiling is 3.950 m.** Assume – i. B. M. on floor and RL of B. M. = 100.000 ii. Instrument on floor. iii. B. S. reading of staff on floor = 1.5 m. H. I. = B. M. + B. S. = 100.000 + 1.5 = 101.5 m R. L. of ceiling = H. I. – (- inverted staff reading) = 101.500 – (-3.950) = 105.45 m Height of roof ceiling = R.L. of roof ceiling – R.L. of floor = 105.45 – 100.00 = 5.45 m. *NOTE: Proportionate marks should be given to any assumed value of B.S. staff reading.*	01 M 02 M 01 M
Q.6		**Attempt any TWO.**	(16)
Q.6	a. Ans.	**Find the area of the field done by cross staff survey.** Plotting the shape of field using the notes in field book.	02 M

Field diagram for Q.6 a:

```
              F              E
              35             40

      A|0    15    45    65    80    95|D
```
```
           30             45
           B              C
```

06 M

Fig No.	Fig.	Chainage (m)	Base (m)	Offsets (m)	Mean offset (m)	Area (m^2) (+)	Area (m^2) (-)
1		0; 15	15	0 & 30	15.0	225	
2		15; 65	50	30 & 45	37.5	1875	
3		65; 95	30	45 & 0	22.5	675	
4		80; 95	15	40 & 0	20.0	300	
5		45; 80	35	35 & 40	37.5	1312.5	
6		0; 45	45	0 & 35	17.5	787.5	
					Total area	5,175	

Total area of the plot ABCDEF is 5175 Sq.m.

| Q.6 | b. | **Find corrected F. B. and B. B. of traverse ABCD.** |

Line	F. B.	B. B.
AB	46^0 30'	225^0 30'
BC	118^0 0'	298^0 0'
CD	168^0 30'	347^0 30'
DA	292^0 0'	110^0 30'

Ans.

Line	F. B.	B. B.	Diff.	Included angle
AB	46^0 30'	225^0 30'	179^0	<A = 64^0 00'

BC	$118^0\,0'$	$298^0\,0'$	180^0	<B = $107^0\,30'$	
CD	$168^0\,30'$	$347^0\,30'$	179^0	<C = $129^0\,30'$	
DA	$292^0\,0'$	$110^0\,30'$	$181^0\,30'$	<D = $55^0\,30'$	
			Total	$356^0\,30'$	01 M

For four sided traverse the included angles sum should be [(2 x 4) − 4)] x 90^0 = 360^0, but the above sum is not 360^0. Therefore included angles have to be corrected.

Correction to each angle = $(360^0 - 356^0\,30')/4$ = $3^0\,30'/4$ = $210'/4$ = +52' 30"

Line	Corrected included angle	Corrected bearing	
		FB	BB
AB	<A = $64^0\,52'\,30"$	$46^0\,22'\,30"$	$226^0\,22'\,30"$
BC	<B = $108^0\,22'\,30"$	$118^0\,00'\,00"$	$298^0\,00'\,00"$
CD	<C = $130^0\,22'\,30"$	$167^0\,37'\,30"$	$347^0\,37'\,30"$
DA	<D = $56^0\,22'\,30"$	$291^0\,15'\,00"$	$111^0\,15'\,00"$

(right margin: 01 M ; 06 M for table and correct values)

Assuming the BB of line BC is correct as diff of BB and FB of line BC is 180^0.

Correct BB of BC = $298^0\,00'$

Correct FB of CD = BB of BC - <C = $297^0\,00' - 130^0\,22'\,30"$
$$= 167^0\,37'\,30"$$

Correct BB of CD = FB + 180^0 = $167^0\,37'\,30" + 180^0$
$$= 347^0\,37'\,30"$$

Correct FB of DA = correct BB of CD - <D = $347^0\,37'\,30" - 56^0\,22'\,30"$
$$= 291^0\,15'\,00"$$

Correct BB of DA = FB of DA - 180^0 = $291^0\,15'\,00" + 180^0$
$$= 111^0\,15'\,00"$$

Correct FB of AB = correct BB of DA - <A = $111^0\,15' - 64^0\,52'\,30"$
$$= 46^0\,22'\,30"$$

Correct BB of AB = correct FB of AB + 180^0 = $46^0\,22'\,30" + 180^0$
$$= 226^0\,22'\,30"$$

Correct FB of BC = correct BB of AB - <B = $226^0\,22'\,30" - 108^0\,22'\,30"$
$$= 118^0\,00'\,00",\text{ which is equal to observed bearing of line BC.}$$

Corrected bearings are tabulated and calculated values are given in table above.

OR

- Assuming line BC is free from local attraction, F.B. of line CD is correct.
- Corrected B.B. of line CD = $168^0\,30' + 180^0$ = $348^0\,30'$
- Error = corrected bearing − observed bearing
- = $348^0\,30' - 347^0\,30'$ = $+1^0$
- Corrected F.B. of line DA = observed bearing + error
- = $292^0\,0' + 1^0$ = $293^0\,0'$
- Corrected B.B. of line DA = corrected bearing - 180^0
- = $293^0 - 180^0$ = 113^0

- Error = corrected bearing – observed bearing
- $= 113^0 0' - 110^0 30' = +2^0 30'$
- Corrected F.B. of line AB = observed bearing + error
- $= 46^0 30' + 2^0 30' = 49^0$
- Corrected B.B. of line AB = observed bearing + 180^0
- $= 49^0 + 180^0 = \mathbf{229^0}$

** **NOTE**: The corrected B.B. of line AB(229) should match with the observed bearing($225^0 30'$) given in the table. Full marks should be given if the problem is solved upto this step OR by first method.

LINE	CORRECTED BEARING		INCLUDED ANGLE FROM CORRECTED BEARINGS
	F.B.	B.B.	
AB	49^0	229^0	A = 64^0
BC	118^0	298^0	B = 111^0
CD	$168^0 30'$	$348^0 30'$	C = $129^0 30'$
DA	293^0	113^0	D = $55^0 30'$
			TOTAL = 360

8 MARKS

Q.6 c. Calculate the reduce level by H. I. method on continuous sloping ground with 4 m leveling staff at common interval of 15 m, 0.905, 1.625, 1.975, 3.050, 0.565, 1.945, 2.855, 3.250, 0.855, 1.015, 2.755. The reduce level of first point is 100 m. Make the entries in the level book and apply usual check.

Ans. The readings are tabulated and calculated values are given in table below.

Chainage	B.S.	I.S.	F.S.	H.I.	R.L.	Remark
00	0.905			100.905	100.00	B. M.
15		1.625			99.280	
30		1.975			98.930	
45	0.565		3.050	98.420	97.855	C.P.1
60		1.945			96.475	
75		2.855			95.565	
90	0.855		3.250	96.025	95.170	C.P.2
105		1.015			95.010	
120			2.755		93.270	Last Pt.
Σ(B.S.)	2.325	Σ(F.S.)	9.055			

06 M for tabulation and correct values

Arithmetic check
$\Sigma(F.S.) - \Sigma(B.S.) = 9.055 - 2.325 = -6.730$
Last RL – 1st RL = 93.270 – 100.00 = -6.730
Since $\Sigma(F.S.) - \Sigma(B.S.) = $ Last RL – 1st RL, Arithmetic check is O.K.
Sample calculations $H.I._1 = $ RL of BM + BS
$= 100.00 + 0.905$
$= 100.905$

01 M

		RL at chainage 30 m = $H.I._1 - I.S.$
		         = $100.905 - 1.975$
		         = 98.930
			01 M