Bapuji Educational Association ®
Bapuji Institute of Engineering and Technology, Davangere – 577 004
Department of Civil Engineering

Course File Check List

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2020-21 odd Sem

Tentative Academic Calendar of VTU, Belagavi for ODD Semester of 2020-2021

	I Sem B. E. / B. Tech. / B. Arch./B.Plan	I sem M.Tech./MBA /MCA/M.Arch.	III, V & VII Sem B. E. /B. Tech./B.Plan/ B.Arch & IX Sem B. Arch.	III & V Sem MCA	III Sem MBA	III Sem M. Tech.	III Sem M. Arch.
Commencement of ODD Semester	Will be announced later	Will be announced later	01.09.2020	01.09.2020	01.09.2020	01.09.2020	01.09.2020
Last Working day of ODD Semester			17.12.2020	17.12.2020	17.12.2020	17.12.2020	17.12.2020
Practical Examinations			21.12.2020 To 31.12.2020	21.12.2020 To 31.12.2020	21.12.2020 To 31.12.2020	21.12.2020 To 31.12.2020	21.12.2020 To 31.12.2020
Theory Examinations			04.01.2021 To 23.01.2021	04.01.2021 To 23.01.2021	04.01.2021 To 23.01.2021	04.01.2021 To 23.01.2021	04.01.2021 To 23.01.2021
Internship Viva-Voce			-	-	-	25.01.2021 To 08.02.2021	-
Professional training / Organization study			-	-	-		-
Commencement of EVEN Semester			08.02.2021	08.02.2021	08.02.2021	22.02.2021	08.02.2021

NOTE

- VII Semester B. E / B. Tech students shall have to undergo INTERNSHIP as per circular of University VTU/Aca/2019-20/85, dated 12.05.2020.
- I Semester B. E/ B. Tech / B. Arch Students shall compulsorily undergo Induction Program for a period of 3 Weeks as per the schedule given by VTU Belagavi
- The classroom sessions for all the higher semesters would be commencing from 01.09.2020(Tentative) in ONLINE mode until further orders.
- The Institute needs to function for six days a week with additional hours.
- The faculty/staff shall be available to undertake any work assigned by the university.
- If any of the above date is declared to be a holiday then the corresponding event will come into effect on the next working day.
- Notification regarding Calendar of Events relating to the conduct of University Examinations will be issued by the Registrar (Evaluation) from time to time.
- Academic Calendar may be modified based on guidelines/directions issued in future by MHRD/UGC/AICTE/State Government.

12.9.2020

REGISTRAR

Bapuji Institute of Engineering and Technology, Davangere-577004

CALENDER OF EVENTS - ODD SEMESTER: SEPTEMBER-JANUARY- 2020-21 (Tentative)

PARTICULARS	I sem BE/B Tech	III, V BE/B.Tech	VII sem BE/B.Tech	III & V sem MCA	III sem MBA	III sem M.Tech
Commencement of ODD Sem	14-12-2020	01-09-2020	01-09-2020	01-09-2020	01-09-2020	01-09-2020
Last Working Day	25-03-2021	16-01-2021	16-01-2021	16-01-2021	16-01-2021	16-01-2021
1st CIE Series	------	19-10-2020 To 24-10-2020	19-10-2020 To 24-10-2020	19-10-2020 To 24-10-2020	15-10-2020 To 17-10-2020	19-10-2020 To 24-10-2020
2nd CIE Series	------	07-12-2020 To 09-12-2020	07-12-2020 To 09-12-2020	07-12-2020 To 09-12-2020	26-11-2020 To 28-11-2020	07-12-2020 To 09-12-2020
3rd CIE Series	------	11-01-2021 To 13-01-2021	11-01-2021 To 13-01-2021	11-01-2021 To 13-01-2021	7-01-2021 To 9-01-2021	11-01-2021 To 13-01-2021
Practical Examination	29-03-2021 Onwards #	21-01-2021 Onwards #	21-01-2021 Onwards #	08-02-2021 Onwards #	-----	21-01-2021 Onwards #
Theory Examination	12-04-2021 To 30-04-2021	08-02-2021 To 27-03-2021	08-02-2021 To 27-03-2021	21-01-2021 To 06-02-2021	21-01-2021 To 19-02-2021	28-01-2021 To 13-02-2021
Internship	------	------	29-03-2021 To 10-04-2021	------	------	------
Internship Viva-Voce	------	-----	------	------	------	15-02-2021 To 22-02-2021
Professional Training/Organization Study	------	------	------	------	22-02-2021 To 03-04-2021	------
Commencement of Even Semester	03-05-2021	29-03-2021	12-04-2021	15-02-2021	05-04-2021	23-02-2021

Notification regarding the calendar of events relating to the conduct of University Examination will be issued by the Registrar (Evaluation) from time to time.

Dean Academic

Principal

Vision of BIET

To be a center of excellence recognized nationally and internationally, in distinctive areas of engineering education and research, based on a culture of innovation and invention.

Mission of BIET

BIET contributes to the growth and development of its students by imparting a broad based engineering education and empowering them to be successful in their chosen field by inculcating in them positive approach, leadership qualities and ethical values

VISION OF THE DEPARTMENT

To train the students to become Civil Engineers with leadership qualities, having ability to take up professional assignments and research with a focus on innovative approaches to cater to the needs of the society.

MISSION OF THE DEPARTMENT

1. To provide quality education through updated curriculum and conducive teaching learning environment for the students to excel in higher studies, competitive examinations and professional career.
2. To impart soft skills, leadership qualities and professional ethics among the graduates to handle the projects independently with confidence.
3. To deal with the contemporary issues and to cater to the socio-economic needs.
4. To build industry-institute interaction and to establish good rapport with alumni.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Core Competence: Graduates will be able to plan, analyse, design and construct sustainable Civil Engineering Infrastructure.

PEO 2: Professional Skills: Graduates will be professional engineers with a sense of ethics, creativity, leadership, self-confidence and independent thinking to cater to the needs of the society.

PEO 3: Societal Needs: Graduates will be able to contribute effectively for the development of industry and professional bodies.

PEO 4: Cognitive Intelligence: Graduates will be able to take up competitive examinations, higher studies and involve in research and entrepreneurship activities.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Students after the completion of the Program will be able to

1. Apply the fundamental concepts, software and codal provisions in the analysis, design and construction of sustainable civil engineering infrastructure.
2. Inculcate professional and leadership qualities, sense of ethics and confidence related to civil engineering.

Faculty will be able to

3. Contribute to the overall development of civil engineering community through the professional bodies and offer services to the society.

3D - CV301
3B - CV305

Name of the Faculty : MER							
Time / Day	8 – 9	9 – 10	10.30 – 11.30	11.30 – 12.30	2 – 3	3 – 4	4 – 5
Mon	18CV32 – A				18CV35 – B		18CVL57 – T (B)
Tue		18CV32 – A					
Wed	18CV35 – B			18CV32 – A	18CVL57 – A3 (MER + SH)		
Thu		18CV35 – B	18CV32 – A		18CVL57 – B1 (MER + GNS)		
Fri		18CVL38 – A1 (MER + CPA)					
Sat		18CV32 – A					

Time Table Coordinator

HOD

Principal

Period : From ...September 2020 To February - 2021 Semester : Odd/Even

Name of the Teacher : Raghu. M.E

Designation : Assistant Professor

Department : civil Department

Sl. No.	Sem. / Sec. / Branch	Subject Name	Subject Code
1	IIIrd | A | civil	Strength of materials	18CV32
2	III | B | civil	Basic surveying	18CV35
3	III | A | A1 | civil	Basic material testing Lab	18CV38
4			
5			
6			
7			

	Reviews at the end of the				End of Semester
	1st Month	2nd Month	3rd Month	4th Month	
Signature of Staff	30.9.2020	30.10.2020	30.12.2020	28.2.2021	21/3/2021
Signature of the Head of Department	30/9/20	31/10/20		28/2/2021	26/3/2021
Signature of the Principal	PRINCIPAL Sapura Institute of Engineering & Technology DAVANGERE.	PRINCIPAL Sapura Institute of Engineering & Technology DAVANGERE.	PRINCIPAL Sapura Institute of Engineering & Technology DAVANGERE.		

Class : III Td Sem. A Section Subject Code : 18CV32 Subject : Strength of Materials Total No. of Classes : 28

Sl No.	USN	NAME	DATE 9/9/20	10/9/20	12/9/20	14/9/20	15/9/20	16/9/20	19/9/20	21/9/20	22/9/20	25/9/20	25/9/20	28/9/20	29/9/20	30/9/20	01/10/20	03/10/20	05/10/20	06/10/20	07/10/20	08/10/20	10/10/20	12/10/20	13/10/20	14/10/20	15/10/20	20/10/20	21/10/20	27/10/20	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
1	4BD19CV001	Aban Sharief	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
2	4BD19CV003	Afzal Noorsabnavar	1	2	A	3	4	5	6	7	8	9	10	A	A	A	A	11	12	13	14	15	16	17	18	19	20	21	22	23						
3	4BD19CV005	Akashdeep R Andanur	1	2	3	4	5	6	7	8	9	A	10	11	12	13	14	15	16	17	18	19	20	A	21	22	23	24	25	26						
4	4BD19CV006	Akhila C Akula	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	A	A						
5	4BD19CV007	Akshatha Ashoka Putalekara	1	2	3	4	5	6	7	8	9	10	11	12	13	14	A	15	16	17	A	18	19	20	21	22	23	24	25	A						
6	4BD19CV009	Akshaya Kumara. L.M	1	2	A	3	4	5	7	A	8	9	A	A	A	10	11	A	A	12	13	A	14	A	15	A	A	A	A	A						
7	4BD19CV011	Amith K.M	1	2	3	A	4	5	6	7	8	9	A	10	11	A	A	A	12	13	A	A	14	15	16	A	A	A	A	17						
8	4BD19CV013	Arpitha Basanagoudapatil	1	2	3	A	4	5	6	A	7	8	A	9	A	10	11	A	12	13	14	15	16	A	12	18	19	20	21	W						
9	4BD19CV015	A Balavaraj S Patil	1	A	2	3	4	A	5	6	A	A	A	A	A	A	A	7	A	8	A	A	9	10	11	12	13	14	15	16						
10	4BD19CV017	Bhumika P.	1	A	2	3	4	5	6	7	8	9	A	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26						
11	4BD19CV019	Chinmayee K.	1	2	3	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27						
12	4BD19CV021	Darshan V.N.	1	A	A	A	A	A	2	3	4	A	5	A	A	A	A	A	A	A	A	6	7	A	A	A	A	8	A	A						
13	4BD19CV023	Ganesh U Shirigeri	1	2	3	4	5	6	7	8	9	10	11	12	13	A	A	14	15	A	16	17	18	19	A	20	21	22	23	24						
14	4BD19CV025	Hemanth kumar DV	A	1	2	A	A	A	A	A	3	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
15	4BD19CV027	A Jhanavi R	1	2	3	4	5	6	7	8	9	10	11	12	13	A	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
16	4BD19CV029	Kruthik. S.P.	1	2	3	4	A	5	A	A	A	A	A	6	A	A	A	7	8	9	10	11	12	A	A	13	14	15	16	17						
17	4BD19CV031	A M Syed Anwar	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
18	4BD19CV033	Manjunatha. M	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
19	4BD19CV035	Mithun. Y	1	A	A	A	2	3	4	A	5	A	6	7	A	A	A	A	A	A	8	9	A	10	A	A	11	A	A							
20	4BD19CV037	Mohammed Faizan makandar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
21	4BD19CV039	Nadeem sha A.Z.	1	A	A	2	3	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
22	4BD19CV041	Nanda K.B	1	2	3	4	5	A	6	A	7	8	9	A	A	10	11	12	13	14	15	16	17	18	19	20	21	22	A	23						
23	4BD19CV043	Niranjan. G.M	1	A	2	3	4	A	5	6	A	7	8	9	A	A	10	A	11	12	A	13	14	A	A	A	A	A	15	A						
24	4BD19CV047	Pooja. P.	1	A	A	A	A	A	2	A	A	A	3	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	4						
25	4BD19CV049	Pradeep. P.N.	1	2	3	4	5	A	6	7	A	A	A	A	A	A	A	A	A	A	A	A	A	9	10	11	A	A	A						
26	4BD19CV051	Prashanth. N.R.	1	2	3	4	5	6	7	8	9	10	11	12	A	A	13	A	14	15	16	17	18	19	20	21	22	23	A	24						
27	4BD19CV053	Raghavendra Vaditre	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
28	4BD19CV055	Rakesh H.N.	1	2	3	4	5	6	7	A	8	A	9	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
29	4BD19CV057	A Sambhram S Patil	1	2	3	4	5	A	6	7	A	A	A	A	B	A	A	8	9	10	11	12	13	14	15	A	A	16	17	18						
30	4BD19CV059	Sevanth B.M	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
		Initials of Teacher																																	
		Initials of H.O.D.																																	
		Initial of Principal																																	

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Class : III A | Subject Code : 18CV32 | Subject : Strength of materials | Total No. of Classes : 56

Sl No.	USN	NAME	DATE 28/10/20	29/10/20	02/11/20	03/11/20	04/11/20	05/11/20	07/11/20	09/11/20	10/11/20	11/11/20	12/11/20	17/11/20	18/11/20	19/11/20	21/11/20	23/11/20	24/11/20	25/11/20	26/11/20	28/11/20	30/11/20	01/12/20	02/12/20	03/12/20	04/12/20	05/12/20	16/12/20	21/12/20	No. of Days Present	%	Test Marks I (30)	Test Marks II (30)	Test Marks III (30)	Average (30)	Remarks
1		Aban Sharief	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1	10	24	23	08	19	29
2		Altaf Noorsabnavar	A	24 A	A	24	25	26	27	A	28	29	30	A	31	32	33	34	A	35	36	37	A	A	38	39	A	40	41	A	2	10	30	30	12	24	34
3		Akashdeep R Andanur	27	28	29	30	30	31	32	33	34	35	36	37	38	39	40	41	42	A	A	43	A	A	A	44	45	46	47	48	3	10	30	30	21	27	37
4		Akhila C Akula	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	43	44	45	46	47	A	48	49	50	51	52	4	10	30	30	19	27	37
5		Akshatha Ashoka P	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	A	48	49	50	52	53	5	10	30	30	15	25	35
6		Akshaya kumara L M	26	A	A	A	A	A	A	A	A	A	28	A	29	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	6	10	29	30	18	26	36
7		Amith K M	A	18 A	18	19	20	21	22	23	24	A	A	25	26	27	A	28	A	A	29	A	30	A	A	4	A	A	A	A	7	10	24	30	14	23	33
8		Arpith Basanagouda Patil	22	23	24	25	26	27	28	29	30	31	32	A	33	A	A	34	35	36	37	38	39	40	41	A	A	42	A	43	08	10	30	30	10	23	33
9		Basavaraj S Patil	17	A	18	19	20	21	A	22	A	A	A	23	24	25	26	27	28	A	A	A	A	29	A	A	30	A	A	A	09	10	26	30	18	19	29
10		Bhumika P	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	10	10	30	30	07	23	33
11		Chinmayee K	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	A	50	A	52	53	54	11	10	30	30	27	27	37
12		Darshan V N	A	09	A	A	A	A	A	A	10	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	12	10	24	24	9	19	29
13		Ganesh U S	25	26	A	A	A	A	27	28	29	30	31	32	33	34	A	35	36	37	38	39	40	41	42	43	44	45	46	A	13	10	30	30	23	28	38
14		Hemanth Kumar D V	A	4 A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	14	10	24	29	03	18	28
15		Jhanavi R	29	30	A	A	31	32	33	34	35	36	37	A	A	38	A	39	A	A	A	A	A	A	A	A	A	A	A	A	15	AB	AB	AB	AB	AB	AB
16		Kruthik S P	18	A	19	20	21	22	A	A	A	A	A	A	23	24	A	25	A	A	A	26	A	A	27	A	A	A	A	A	16	10	30	30	17	26	36
17		M Syed Anwar	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	17		Left the course				
18		Manjunatha M	29	A	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	18	10	30	30	24	28	38
19		Mithun Y	A	12 A	A	A	A	A	A	A	A	A	A	A	A	A	A	12	A	A	A	A	13	14	15	16	16	17	18		15	10	21	19	02	14	24
20		Mohammed Faizan Mantalder	29	A	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	46	47	48	49	50	51	52	53	54	20	10	26	30	21	26	36
21		Nadeemsha A Z	A	3 A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	21	10	25	23	13	21	31
22		Nanda K B	24	25	26	27	28	29	30	31	32	A	33	34	35	36	37	38	39	A	40	A	41	42	43	44	A	A	45		22	10	30	30	21	27	37
23		Niranjan G M	A	16 A	A	16	A	A	A	A	17	18	A	A	19	20	A	21	22	23	24	A	A	25	A	A	A	26	27	28	23	10	25	30	05	22	32
24		Pooja P	A	5 A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	5	A	A	A	A	A	A	24	10	25	30	09	19	29
25		Pradeep P N	A	11 A	A	A	A	A	A	A	A	A	11	A	12	13	A	14	15	A	A	15	16	17	18	19	20	21	22	A	A	25	10	23	21	04	16	26
26		Prashanth N R	A	25 A	A	26	27	A	A	28	A	29	A	A	30	34	32	33	34	A	35	36	37	38	A	39	40	41	A	A	26	10	24	28	12	22	32
27		Raghavendra V	A	2 A	A	A	A	A	2	A	3	A	4	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	27	10	30	30	04	22	32
28		Rakesh H N	A	10 A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	28	10	25	21	12	20	30
29		Sambhram Shahi	19	A	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	A	A	36	A	37	38	39	40	41		29	10	26	30	AB	19	29
30		Sevanth	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	30	10	30	23	08	21	31
		Initials of Teacher																																	
		Initials of H.O.D.																																	
		Initial of Principal																																	

PRINCIPAL
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Class : 3rd sem A Subject Code : 18CV32

Subject : Strength of materials Total No. of Classes : 28

Sl No.	USN	NAME	DATE	9/9/20	10/9/20	12/9/20	14/9/20	15/9/20	16/9/20	19/9/20	21/9/20	22/9/20	23/9/20	25/9/20	28/9/20	29/9/20	30/9/20	01/10/20	03/10/20	05/10/20	06/10/20	07/10/20	08/10/20	10/10/20	12/10/20	13/10/20	14/10/20	15/10/20	20/10/20	21/10/20	27/10/20	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
31	4BD19CV061	Shreya D.K.		A	A	A	A	A	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A	A	A	A							
32	4BD19CV063	Soundarya. N.M		1	2	3	4	5	6	7	8	9	10	A		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	A	A					
33	4BD19CV065	Swathi V Kote		1	2	3	4	5	6	7	8	9	10	11		12	13	14	15	11	17	18	19	20	21	22	23	24	25	26	27	28					
34	4BD19CV067	U madhushree		1	2	3	4	5	6	7	8	9	10	11		12	13	14	15	16	17	A	A	A	18	19	20	21	22	23	24	25					
35	4BD19CV069	Vaishnavi. V.		1	2	3	4	5	6	7	8	7	10	11		12	13	14	15	16	17	A	A	A	18	19	20	21	22	23	24	25					
36	4BD19CV070	Veeresh K.K.		1	2	A	3	A	A	4	5	6	7	8		9	A	A	A	10	11	12	A	13	14	15	16	17	18	19	A	20					
37	4BD19CV073	Vijayalakshmi R. Telkar		1	2	3	4	5	6	7	8	9	10	11		12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28					
38	4BD19CV075	Vikas S.M.		1	A	A	2	3	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A	4	5	6	A	7	A					
39	4BD19CV077	Vivekananda. H.M.		1	2	A	A	A	A	A	A	A	A	A		A	A	A	A	3	4	5	A	A	A	A	6	7	8	9	10	11					
40	4BD19CV079	Yugh B. Jain		A	A	A	A	A	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A	1	2	3	4	A	A					
41	4BD18CV099	Vinay kumar M		A	1	A	A	A	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A	A	A	A	2	3					
42	4BD17CV052	Mohammed Azhar Baith		Admission on 21/09/2020										A		1	A	2	3	4	5	A	6	7	A	A	8	9	A	A	A					
43		Trupthi. S.R.		Admission on 1/1/2020										A		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A					
44	4BD18CV027	Harshith. N.		Admission on 07/10/2020																																
45		Channeah. H. Patil		Admission on 06/10/2020																			A	1	2	3	4	5	6	7	8					
46	4BD18CV076	A Shivaraj K.H		Admission on 05/10/2020																			1	2	3	A	A	A	4	5						
47		Bharath Reddy N		Admission on 14/10/2020																							A	1	A							
48		A Mohammed Khadir		Admission on 16/10/2020																							A	1	2							
49		Abhilash S.V.		Admission on 3/11/2020																							A	A	A							
50		Dhanush R.		Admission on 4/11/2020																																
51		Surabhi S. Bharadwaj		Admission on 03/11/2020																																
52		Chethan Kotrayath		Admission on 09/11/2020																																
53		Vinod Kumar Budhiha		Admission on 13/11/2020																																
54		Nandesh M Mathod		Admission on 13/11/2020																																
55	change of Branch	Santhosh S Bagoor		Admitted on 14/11/2020																																
56	4BD17CV160	A Sujith R		Admitted on 15/11/2020																																
57		Rohith A		" " 20/11/2020																																
58	Change of Branch	Kiran M.M		Admitted on 2.2/11/2020																																
59		Suhas. N. Raikar		Admitted on 22/11/2020																																
60		Murugharajendra. H.V		Admitted on 25/11/2020																																
61		Shree Harsha J.R																																		
		Initials of Teacher																																		
		Initials of H.O.D.																																		
		Initial of Principal																																		

PRINCIPAL
Sahyadri Institute of Engineering & Technology
DAVANGERE

Class : III A-section Subject Code : 18CV32 Subject : Strength of Materials Total No. of Classes : 56

Sl No.	USN	NAME	DATE 28/10/20	29/10/20	2/11/20	03/11/20	04/11/20	05/11/20	07/11/20	09/11/20	10/11/20	11/11/20	12/11/20	17/11/20	18/11/20	19/11/20	21/11/20	23/11/20	24/11/20	25/11/20	26/11/20	28/11/20	30/11/20	1/12/20	2/12/20	12/12/20	14/12/20	15/12/20	16/12/20	21/12/20	No. of Days Present	% 10	Test Marks I 30	II 30	III 30	Average 30	Remarks 40
31		Shreya. D.K	A	3	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	31	10	24	23	02	17	27
32		Soundarya. N.M	26	A	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	A	51	32	10	30	30	19	27	37
33		Swathi V Kote.	A	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	45	42	48	49	50	51	52	53	54	55	33	10	30	30	11	24	34
34		U Madhushree	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	34	10	30	28	28	26	36
35		Vaishnavi .V.	25	27	28	29	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	A	46	47	48	49	50	51	52	53	35	10	30	30	20	27	37
36		Veeresh. K. R.	A	21	22	23	24	A	26	04	27	A	A	A	A	A	A	A	A	A	A	A	A	A	28	A	A	A	29	36	10	30	25	01	20	30
37		Vijayalakshmi. R. Telkar	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	37	10	30	30	20	27	37
38		Vikas. S.M.	8	A	A	9	A	10	A	11	12	A	13	A	A	A	A	A	A	14	A	A	A	15	A	A	16	A	A	A	38	10	17	30	00	16	26
39		Vivekananda. H-M	12	A	13	14	15	16	17	18	19	A	20	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	39	10	30	22	01	18	28
40		Yugh B Jain	A	5	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	40	10	26	30	12	23	33
41		Vinay kumar. M.	A	A	A	4	5	6	A	A	7	A	A	8	9	A	A	10	A	A	A	A	A	11	A	A	A	A	A	12	41	10	24	23	05	19	29
42		Mohammed Azhar Baisth	10	A	A	A	11	A	12	A	13	A	A	A	A	A	A	A	14	A	15	A	A	16	17	A	A	A	18	19	42	10	21	25	06	18	28
43		Truptha. S-R.	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	43	10	30	30	02	21	31
44		Harshith - N.	9	10	11	A	12	13	14	15	16	17	18	A	19	A	20	21	22	A	23	24	25	A	26	27	28	29	30	31	44	10	30	30	07	23	33
45		Channeah. H. Patil	6	7	A	A	8	9	10	11	12	13	14	15	16	A	17	18	19	20	A	21	22	23	A	24	25	26	27	28	45	10	28	30	01	20	30
46		Shivaraj. K. H.	A	2	3	A	4	A	5	6	7	8	9	10	11	A	12	A	13	14	A	15	16	17	A	18	A	A	19	A	46	10	18	27	AB	15	25
47		Bharath Reddy	3	A	A	4	5	A	6	A	7	A	8	A	A	A	A	9	A	10	A	A	A	A	A	A	A	11	A	A	47	10	27	29	03	20	30
48		Mohammed Ikhadir	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	48	10	30	30	06	22	32
49		Abhilash S.V	4			A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	49	10	30	30	04	22	32
50		Dhanush. R.	4					A	A	A	1	A	A	A	A	A	A	A	A	A	2	3	4	5	A	A	A	A	A	50	10	28	24	01	18	28
51		Surabhi. S. Bharadwaj	4						A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	51	10	30	30	00	20	30
52		Chethan Kotraiah.	2							A	1	2	3	A	A	A	A	4	A	5	A	6	A	7	A	8	9	10	11	52	10	24	27	06	19	29
53		Vinod kumar M Mathad	4											A	A	A	1	2	3	A	A	4	5	6	7	A	8	A	A	9	53	10	30	20	00	17	27
54		Nandesh M Mathad.	4											A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	54	10	30	30	07	23	33
55	Change of Branch	~~Nandesh M Mathad~~ Sauthosh R Bagur	4												A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	55	10	30	28	07	22	32
56	Change of Branch Name Revised	~~Sauthosh S Bagur~~ Sujith. R	4												A	A	1	A	A	A	A	A	A	A	A	A	A	A	A	56	Left the course					
57	~~Change of Branch~~	~~Sujith~~ R. Rohith. N	4														1	2	3	4	5	A	6	7	A	A	A	A	A	57	10	30	30	04	22	32
58	Change of Branch	Rohith A. Kiran. N.M	4														A	A	A	A	A	A	A	A	A	A	A	A	A	58	10	23	30	10	21	31
59	~~Change of Branch~~	Suraj N.M Reibar Kiran N.M																																	
60		Murugharaj reddy. H.V	4																											60	10	30	30	01	21	31
61	Shree harsha. J.R	Shree harsha J.R.																							1	2	3	4		61	10	30	30	03	21	31
		Initials of Teacher																																	
		Initials of H.O.D.																																	
		Initial of Principal																																	

PRINCIPAL
Jaipuri Institute of Engineering & Technology
DAVANGERE.

Class : III A Section | Subject Code : 18CV32 | Subject : Strength of Materials | Total No. of Classes : 54

Sl No.	USN	NAME	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
62		Sandeep B.N.	62	10	29	30	05	22	32
63		Shankar Rao K.	63	10	30	28	02	20	30
64		Ambika. H.J.	64	10	30	25	21	26	36
65		Triveni.G.	65	10	30	27	13	24	34
66		Dallavi. O.	66	10	30	30	20	27	37
67		Harish. S.D	67	10	17	16	6	13	23
68		Veena. B Bharamgoudra.	68	10	30	30	02	21	31
69		Harsha. C.N.	69	10	30	30	17	26	36
70		Harish. L.G.	70	10	30	27	01	20	30
71		Tripathi S. Balkar	71	10	30	30	04	22	32
72		Deepak. L	72	10	30	28	11	23	33
73		Fridoosh Anjum. H	73	10	30	28	05	21	31

Initials of Teacher

Initials of H.O.D.

Initial of Principal

PRINCIPAL
Sahyadri Institute of Engineering & Technology
DAVANGERE

Class : III B Section Subject Code : 18CV35

Subject : Basic surveying Total No. of Classes : 28

Sl No.	USN	NAME	DATE	10/9/20	14/9/20	19/9/20	11/9/20	21/9/20	23/9/20	28/9/20	30/9/20	01/10/20	05/10/20	07/10/20	12/10/20	14/10/20	15/10/20	21/10/20	22/10/20	28/10/20	29/10/20	04/11/20	05/11/20	09/11/20	11/11/20	18/11/20	19/11/20	23/11/20	25/11/20	26/11/20	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
1	4BD19CV002	Abhishek K Chitragar		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
2	4BD19CV004	Ajay A Jajuri		1	2	3	4	5	6	7	8	A	A	9	10	A	11	12	13	A	14	15	A	16	A	A	A	17	A	A	A						
3	4BD19CV008	Akshay B M.		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
4	4BD19CV010	Ali Akbar		A	A	A	A	A	A	A	A	A	A	1	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
5	4BD19CV012	Anusha S.		1	A	A	A	2	A	3	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
6	4BD19CV014	B Sayyed Ismail Zabiulla		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
7	4BD19CV016	Bharathgouda K.N.		A	A	A	A	A	A	1	A	2	3	4	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
8	4BD19CV018	Chandan B.V		A	A	1	2	3	A	4	5	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
9	4BD19CV022	Deepa P.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
10	4BD19CV024	Harish K.T.		A	A	A	A	A	1	2	A	3	A	4	A	5	6	7	8	9	A	A	A	A	A	A	10	A	A	11	A						
11	4BD19CV028	Karthik D Vernekar		1	2	3	4	5	6	7	A	A	A	A	A	A	A	8	A	A	A	A	A	A	A	A	A	A	A	A						
12	4BD19CV030	Lakshmi. B.S		1	A	2	3	A	A	4	A	A	A	5	A	A	6	7	8	A	A	A	A	9	A	10	A	A	11	12	13						
13	4BD19CV032	Mallikarjun. T.M.		1	2	3	4	5	6	7	8	9	10	A	A	A	A	12	13	A	A	A	14	A	15	A	A	A	A	16	A						
14	4BD19CV034	Manoj Swamy K.M		1	2	3	4	5	6	7	8	9	10	11	A	12	13	14	15	A	16	17	18	19	20	21	22	23	24	25	26	A					
15	4BD19CV036	Mohammed Ameerkhan D		1	2	3	4	A	A	A	A	A	A	A	A	5	6	A	A	A	A	A	7	A	A	A	A	A	A	A	A						
16	4BD19CV038	Mohit B V		1	2	A	A	A	3	4	5	A	A	A	A	6	7	8	A	9	10	11	A	12	13	14	15	16	A	A	17						
17	4BD19CV040	Namratha P Ram		A	A	1	2	A	3	4	5	6	A	7	A	A	A	A	9	A	A	A	A	A	A	A	A	A	A	A	A						
18	4BD19CV042	Nandini. K.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	A	A	A	A	24						
19	4BD19CV044	P.N. Mohammed Sylaudin		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
20	4BD19CV046	Pooja. M.P.		A	1	2	3	4	5	6	7	8	9	10	11	A	12	13	14	A	15	16	A	17	18	A	19	20	A	21	22						
21	4BD19CV048	Pradeep. K.B		A	A	1	2	A	3	4	5	A	A	6	A	A	7	8	9	A	10	A	11	12	A	13	14	15	16	17	18						
22	4BD19CV050	Prajwal G.T Matad		1	2	3	4	5	6	7	A	A	8	9	A	10	11	12	13	14	15	A	A	A	A	A	16	A	A	17	A						
23	4BD19CV052	Prerana. V.		1	2	3	4	5	6	7	8	9	10	11	12	A	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27						
24	4BD19CV054	Raghu. Doddamani		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
25	4BD19CV056	Rukaar Banu. A.K		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
26	4BD19CV058	Sanjay. G.A.		1	2	3	4	5	6	7	8	A	A	A	A	A	A	A	9	10	A	11	12	13	A	14	15	A	A	A	A						
27	4BD19CV060	Shashi Kiran. C.R		1	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A						
28	4BD19CV062	Siraj Ahamed Y.B.		1	A	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	A	25	26	27						
29	4BD19CV064	Sunil N Rathod.		A	1	A	A	A	A	2	A	A	3	4	A	5	A	6	7	A	A	8	A	9	A	10	11	A	12	13	A						
30	4BD19CV066	Tejaswini. M.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
.																																			
		Initials of Teacher																																		
		Initials of H.O.D.																																		
		Initial of Principal																																		

PRINCIPAL
Sapuji Institute of Engineering & Technology
DAVANGERE.

Class : III B Section

Subject Code : 18CV35

Subject : Basic surveying

Total No. of Classes : 56

Sl No.	USN	NAME
1	4BD19CV002	Abhishek K C
2	4BD19CV004	Ajay A Jaju
3	4BD19CV008	Akshay B M
4	4BD19CV010	Ali Akbar
5	4BD19CV012	Anusha S.
6	4BD19CV014	B Sayyed Ism
7	4BD19CV016	Bharathgouda
8	4BD19CV018	Chandan B.V
9	4BD19CV022	Deepa P.
10	4BD19CV024	Harish K.T.
11	4BD19CV028	Karthik D Ver
12	4BD19CV030	Lakshmi B.S
13	4BD19CV032	Mallikarjun
14	4BD19CV034	Manoj Swamy
15	4BD19CV036	Mohammed Ame
16	4BD19CV038	Mohit B V
17	4BD19CV040	Namratha P
18	4BD19CV042	Nandini K.
19	4BD19CV044	P N Mohammed
20	4BD19CV046	Pooja M P
21	4BD19CV048	Pradeep K B
22	4BD19CV050	Prajwal G.T.
23	4BD19CV052	Prerana V.
24	4BD19CV054	Raghu Dodd
25	4BD19CV056	Rukaar Ban
26	4BD19CV058	Sanjay G.
27	4BD19CV060	Shashi Ki
28	4BD19CV062	Siraj Ahamed
29	4BD19CV064	Sunil N Rath
30	4BD19CV066	Tejaswini M

DATE	02/12/20	14/12/20	16/12	21/12	23/12	28/12/20	30/12/20	31/12/20	4/1/21	5/1/21	7/1/21	19/1/21	17/1/21	21/1/21	01/2/21	3/2/21	4/2/21	10/2/21	11/2/21	14/2/21	15/2/21	17/2/21	4/2/21	18/2/21	18/2/21	19/2/21	23/2/21	25/2/21	26/2/21	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
1	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1	AB	AB	AB	AB	AB	AB
2	18 A	A	A	A	18	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	2	10	24	24	10	17	27
3	k	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	3	10	21	23	9	18	28
4	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	4	10	25	16	3	15	25
5	4	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	5	AB	AB	AB	AB	AB	AB
6	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	6	10	24	21	10	15	25
7	8	A	A	A	A	A	A	A	A	A	A	A	A	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	7	10	25	23	10	16	26
8	9	A	A	A	10	A	A	A	A	A	A	A	A	11	12	13	14	15	A	A	A	A	A	A	16	17	18	19	8	16	26	32	12	23	33
9	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	9	10	30	30	25	29	39
10	12 A	A	12	A	A	A	A	A	A	A	A	A	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	10	10	22	20	3	15	25
11	13 A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	11	AB	AB	AB	AB	AB	AB
12	14 A	A	A	A	14	A	A	A	A	A	A	14	A	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	12	10	27	30	08	22	32
13	15 A	A	19	A	18	19	20	21	A	A	A	A	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	13	10	26	23	11	20	30
14	27	28	A	A	29	30	31	32	A	33	A	34	35	A	36	37	38	39	40	41	42	43	44	45	46	47	48	49	14	10	26	25	13	22	32
15	17 A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	10	11	12	13	14	15	16	17	18	19	20	21	15	10	22	14	01	13	23
16	18	A	19	A	20	21	22	23	A	24	25	26	A	A	27	28	29	30	31	32	33	34	35	36	37	38	39	40	16	10	25	26	07	20	30
17	10 A	A	A	A	A	A	A	A	A	A	A	A	A	A	10	11	12	13	14	15	16	17	18	19	20	21	22	23	17	10	22	30	07	20	30
18	25 A	25	26	27	A	28	29	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	18	10	28	30	21	27	37
19	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	19	10	20	18	10	13	23
20	23 A	23	24	25	26	27	28	29	30	31	32	33	34	A	35	36	37	38	39	40	41	42	43	44	45	46	47	48	20	10	26	18	15	20	30
21	19	A	A	20	21	22	23	24	25	26	27	28	29	A	30	31	32	33	34	35	36	37	38	39	40	41	42	43	21	10	27	26	03	19	29
22	28 A	A	A	A	A	A	A	A	A	A	A	A	A	A	18	19	20	21	22	23	24	25	26	27	28	29	30	31	22	10	28	26	14	23	33
23	28	29	30	31	32	33	34	35	36	37	38	39	A	A	40	41	42	43	44	45	46	47	48	49	50	51	52	53	23	10	26	30	17	25	35
24	A	A	A	A	A	A	A	A	A	A	A	A	A	A	3	4	5	6	A	8	9	10	11	12	13	14	15	16	24	10	16	23	10	13	23
25	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	25	10	30	30	26	29	39
26	16	A	A	A	A	A	A	A	A	A	A	A	A	A	17	18	19	20	21	22	23	24	25	26	27	28	29	30	26	10	25	23	17	22	32
27	2 A	A	A	A	A	A	A	A	A	A	A	A	2	A	3	4	5	6	7	8	9	10	11	12	13	14	15	16	27	10	27	23	10	20	30
28	28	A	A	29	A	30	31	A	A	32	33	34	35	A	36	37	38	39	40	41	42	43	44	45	46	47	48	49	28	10	30	26	22	32	32
29	14	A	15	16	17	A	A	A	A	18	19	A	A	A	20	21	22	23	24	25	26	27	28	29	30	31	32	33	29	10	28	23	05	19	29
30	29	A	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	30	10	30	30	23	28	28

Initials of Teacher

Initials of H.O.D.

Initials of Principal

PRINCIPAL
Sapuji Institute of Engineering & Technology
DAVANGERE.

Class : III B Section Subject Code : 18CV35

Subject : Basic Surveying Total No. of Classes : 28

Sl No.	USN	NAME	DATE	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
31	4BD19CV068	Vaishnavi. V.								
32	4BD19CV070	Veeresh B. R. S. V								
33	4BD19CV072	Vemon M Hiravaddi								
34	4BD19CV074	Vikas D. Yadav								
35	4BD19CV076	Vivek A P N								
36	4BD19CV078	Yashaswini. M.U.								
37	4BD19CV080	Zaiba Anjum								
38	4BD18CV090	Tejash. B.R								
39	4BD17CV065	Pavan K.G.D.								
40	4BD18CV024	Ganesh. B.G.								
41	4BD18CV047	Mohan. A.P.	24/9/2020							
42	4BD18CV078	Siddesh Gowda. M.S	24/9/2020							
43	4BD18CV092	Uday. K.H.	1/10/2020							
44	4BD17CV025	Dishanth	04/10/2020							
45	4BD17CV002	Adarsh N.G.	5/10/2020							
46	[illegible]	Shreyas. R.	06/11/2020							
47	4BD18CV075	Shashanka N.R	23/10/20							
48		Mohan Kumar S.B.	29/10/2020							
49		Sharath. K.R.	03/11/2020							
50		Chetan. G	06/11/2020							
51		Chirudeep. J.	7/11/2020							
52		Vinay. K.	9/11/2020							
53		Hyla Swamy	12/11/2020							
54	Changed Branch	Rathan. R. Rathod	18/11/2020							
55		Hemanth. H. V.	18/11/2020							
56		Prajwal Kumar. S.K.	20/11/2020							
57		Sohaan.	Admission 20/11/2020							
58		Rohith kumar N.L	Admission on 28/11/2020							
59		Vinay D.V.	Admitted on 24/11/2020							
60		Darshan. D Amogh H.G	Admitted on 21/11/2020							
61		Akshay. D.	Admitted on 9/11/2020							
		Initials of Teacher								
		Initials of H.O.D.								
		Initial of Principal								

PRINCIPAL
Jspm Institute of Engineering & Technology
DAVANGERE.

Class : III 'B' Section

Subject Code : 18CV35

Subject : Basic Surveying

Total No. of Classes : 56

Sl No.	USN	NAME	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
31	4BD19CV068	Vaishnavi	31	10	27	26	13	22	32
32	4BD19CV070	Veeresh B.	32	10	27	23	03	18	28
23	4BD19CV072	Veman M [illegible]	33	10	22	22	11	19	29
34	4BD19CV074	Vikas D.	34	10	26	23	13	21	31
35	4BD19CV076	Vivek A P	35	10	18	26	13	19	29
36	4BD19CV078	Yashaswini.	36	AB	AB	AB	AB	AB	AB
37	4BD19CV080	Zaiba Anji	37	10	30	30	20	27	37
38	4BD18CV090	Tejash. B.R	38	10	26	25	04	19	29
39	4BD17CV065	Pavan K.C	39	10	26	20	06	18	28
40	4BD18CV024	Ganesh. B.C	40	10	19	15	15	17	27
41	4BD18CV047	Mohan. A.H.	41	10	27	22	03	18	28
42	4BD18CV078	Siddesh Gowda	42	10	17	19	09	15	21
43	4BD18CV092	Uday K.H.	43	10	12	21	8	14	24
44	4BD17CV025	Dishanth	44	AB	AB	AB	AB	AB	AB
45	4BD17CV002	Adarsh. N.G.	45	AB	AB	AB	AB	AB	AB
46	[illegible]	Shreyas. R.	46	10	30	25	19	25	35
47	4BD18CV037	Shashanka N.	47	10	23	23	07	18	28
48		Mohan Kumar	48	10	28	26	13	23	33
49		Sharath. K.R.	49	10	30	27	14	24	34
50		Chetan. G.	50	10	27	25	10	21	31
51		Chirudeep. J	51	10	24	20	05	17	27
52		Vinay. K.	52	10	26	17	13	19	29
53		Hyla Swamy	53	10	25	22	13	20	30
54	Changed Branch	Rathan. R. Ra	54	10	30	25	14	23	33
55		Hemanth. H	55	10	26	30	23	27	37
56		Prajwal Kum	56	09	19	14	09	13	21
57		Sohaan.	57	10	30	20	06	19	29
58		Rohith kuma	58	10	30	26	16	24	34
59		Vinay D.V.	59	10	27	26	06	20	30
60		Darshan. D A	60	10	26	25	17	23	33
61		Dakshay. D.	61	10	27	29	05	21	31

Initials of Teacher

Initials of H.O.D.

Initials of Principal

PRINCIPAL
Jaipuji Institute of Engineering & Technology
DAVANGERE.

Class : III B

Subject Code : 18CV35

Subject : Basic Surveying

Total No. of Classes : 56

Sl No.	USN	NAME	DATE	14/12/20	16/12/20	21/12/20	23/12/20	28/12/20	30/12/20	31/12/20	4/1/21	5/1/21	13/1/21	19/1/21	21/1/21	1/2/21	3/2/21	8/2/21	10/2/21	13/2/21	15/2/21	17/2/21	17/2/21	18/2/21	18/2/21	19/2/21	22/2/21	24/2/21	26/2/21	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
62	1	Harshith. B.P	22.12.2020					1	2	3	A	A	A	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20						
63		Sandeep. K	23.12.2020					A	A	A	A	A	A	1	2	3	4	5	A	6	7	8	9	10	11	12	13	14	15						
64		Abhishek. H	23.12.2020					A	1	A	A	A	A	1	2	3	4	5	A	6	7	8	9	10	11	12	13	14	15						
65		Vinay H.R	23.12.2020					A	1	A	A	A	A	1	2	3	4	5	A	6	7	8	9	10	11	12	13	14	15						
66		Chidananda. H	23.12					A	1	A	A	A	A	1	2	3	4	5	A	6	7	8	9	10	11	12	13	14	15						
67		Kallesh. M.N	24.12					A	A	A	A	A	A	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
68		Bhavana. M	30.12							A	A	A	A	1	2	3	4	5	A	6	7	8	9	10	11	12	13	14	15						
69		Ganesh. L	31.12							1	2	3	A	A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17				
70		Muralidhar. B.	31.12								A	A	A	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				
71		Mithun Chavan	31.12								A	A	A	1	2	3	4	5	A	6	7	8	9	10	11	12	13	14	15						
72		Mohammed Shadab Azeez	31.12								1	A	A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16						
73		Mohammed Thoufik. Y												1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16						

Initials of Teacher

Initials of H.O.D.

Initial of Principal

PRINCIPAL
Sahyadri Institute of Engineering & Technology
DAVANGERE.

Class : III B Subject Code : 18CV35

Sl No.	USN	NAME	DATE											
62	1	Harshith. B D						1	2	3	A	A	C	
63		Sandeep. K						A	A	A	A	A	A	
64		Abhishek. H						A	1	A	A	A	A	
65		Vinay H. R						A	1	A	A	A	C	
66		Chidananda. H						A	1	A	A	A	2	
67		Kallesh. M N						A	A	A	A	A	A	
68		Bhavana. M								A	A	A	1	
69		Ganesh. L								2	3	A	4	
70		Muralidhar. B									A	A	1	
71		Mithun chavan									A	A	A	
72		Mohammed chedas A2009								1	1	A	A	
73		Nikhil												

Initials of Teacher

Initials of H.O.D.

Initial of Principal

Class : III B

Sl No.	USN	NAME

Initials

Initials

Initial

Total No. of Classes : 56

No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
64	10	30	23	13	22	32
63	10	22	30	16	23	33
66	10	24	30	30	28	38
65	10	28	26	8	21	31
66	10	30	23	18	24	34
67	10	25	17	14	19	29
61	10	30	26	12	23	33
63	10	26	30	10	22	32
70	10	28	29	26	28	38
71	10	30	20	16	22	32
72	10	26	26	20	24	34
73	10	26	28	14	23	33

PRINCIPAL
Jawaharlal Institute of Engineering & Technology
DAVANGERE.

Class : III A Subject Code : 18CVL38

Subject : Basic Materials Testing lab Total No. of Classes : 10

Sl No.	USN	NAME	DATE	8/1/21	8 Jan 21	15/01/21	29/01/21	5/02/21	12/02/21	19/02/21	26/02/21	1/3/21	5/3/21	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
1	4BD19CV001	Aban Sharif		1	2	A	4	5	6	7	8	A	9			20	+10	30	1	30
2	4BD19CV003	Afzal Noorsabnavar		A	A	2	3	4	A	5	6	7	8			22	+14		=	36
3	4BD19CV005	Akashdeep R Andanur		1	2	3	4	5	6	7	8	9	10			23	+15		=	38
4	4BD19CV006	Akhila C Akula		1	2	3	4	5	6	7	8	9	10			24	+15		=	39
5	4BD19CV007	Akshatha Arkoka Puthukkoy		1	A	3	4	5	6	7	8	9	10			24	+16		=	40
6	009	Akshaya kumara. L.M.		1	2	3	4	5	A	7	8	A	9			22	+13		=	35
7	011	Amith K.M.		A	1	A	2	3	4	A	5	A	5			22	+13		=	35
8	013	Arpitha Balanagouda Patil		1	2	3	4	A	A	5	6	7	8			24	+15		=	39
9	015	Balavaraj S Patil			A	A	A	A	A	A	A	A	A			19	+10		1	29
10	017	Bhumika P.		1	2	3	4	5	6	7	8	9	10			23	+15		=	38
11	019	Chinmayee. k.		1	2	3	4	5	A	7	8	9	11			24	+15		=	39
12	021	Darshan V.N.		1	2	A	4	5	1	A	6	7	8			20	+14		=	34
13	023	Ganesh U Shirigeri		1	2	A	3	4	5	A	6	7	8			24	+14		=	38
14	025	Hemanth Kumar. B.V.		1	2	A	4	5	A	A	6	7	8			23	+14		=	34
15	4BD18CV099	Vinay Kumar. M		1	2	A		A	A	A	A	A	A			20	+13		=	33
16	4BD18CV027	Harshith N		1	2	3	4	5	6	A	7	A	A			21	+13		=	34
17		Bharath Reddy N		1	2	3	4	5	A	6	7	8	7			22	+14		=	36
18		Dhanush. R		A	1	A	3	4	5	6	7	8	10			23	+14		=	37
19		Vinod kumar Budhihal		1	A	2	3	4	5	6	7	8	9			22	+11		=	33
~~20~~	~~4BD17CV~~	~~Sujith R~~		~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~	~~A~~			~~left~~	~~College~~			
21		Suraj N. Naikar		1	2	A	4	5	6	7	8	9	10			22	+15		=	37
22		Sandeep B.N		1	2	A	3	A	4	5	6	7	8			24	+15		=	39
23		Triveni G.		1	2	3	4	5	6	7	8	9	10			23	+14		=	37
24		Veena B Bharamagoudra		1	2	A	3	4	A	6	7	8	7			23	+14		=	37
25		Truptha Balikai		A	A	A	2	3	A	5	6	7	8			23	+14		=	37
		Initials of Teacher																		
		Initials of H.O.D.																		
		Initial of Principal																		

PRINCIPAL
Jain Institute of Engineering & Technology
DAVANGERE.

Class : 3 A Subject Code : 18CV32

Subject : Strength of Materials Total No. of Classes : 94

Sl No.	USN	NAME	DATE	23/12/20	26/12/20	28/12/20	23/11/20	30/11/20	02/12/20	05/12/20	06/12/20	07/12/20	09/12/20	10/12/20	14/12/20	16/12/20	17/12/20	18/12/20	21/12/20	23/12/20	24/12/20	25/12/20	27/12/20	28/12/20	29/12/20	1/1/21	2/1/21	3/1/21	4/1/21	6/1/21	8/1/21	10/1/21	11/1/21	Total Marks	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
1	4BD15CV001			5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	40								
2	003			42	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68								
3	005			49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76								
4	006			53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80								
5	007			54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81								
6	009			29 A	30	31	32	33	34	35	36	37	28	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50								
7	011			44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71								
8	013			44 A	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71								
9	015			31 A	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58								
10	017			55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82								
11	019			55 A	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82								
12	021			47	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	47								
13	023			47 A	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	83								
14	025			5 A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	42								
15	027			28 A	Change				7			Bracket																											
16	029			28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	85								
17	031						Inlet				Voltage																												
18	033			55	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	93								
19	035			19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	35	40	41	42	43	46	45	55								
20	037			55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	91								
21	039			5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	41								
22	041			45	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	82								
23	043			29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	61	55	50	51	A	52	63	64	65								
24	047			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	26	25	26	27	28	29	30	31	32	42								
25	049			23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	35	40	41	42	43	44	45	46	47	48	43	55								
26	051			42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	55	60	61	62	63	64	65	66	67	68	63								
27	053			5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32								
28	055			11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	48								
29	057			42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	38								
30	057.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	37								
31																																							

Initials of Teacher

Initials of H.O.D.

Initial of Principal

PRINCIPAL
Sapuji Institute of Engineering & Technology
DAVANGERE.

Class : 3rd Subject Code : 18CV32

Subject : Strength of Materials Total No. of Classes : 94

Sl No.	USN	NAME	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
31	4BD18CV061								
32	63								
33	65								
34	67								
35	69								
36	71								
37	73								
38	75								
39	77								
40	79								
41	4BD18CV099	Vinay Kumar. M.							
42	4BD17CV052	Mohammed Azhar Baitha							
43		Trupthi. S. R.							
44	4BD18CV027	Harshith. N.							
45		Channesh. H. Rishi							
46	4BD18CV076	Shivaraj. K. H.							
47		Bharath Reddy N							
48		Mohammed Ishaq IV							
49		Abhilash. B. V							
50		Dhanush. R							
51		Surabhi S. Bharadwaj							
52		Chethan Kottaichi.							
53		Vinod Kumar Budihal							
54		Nandish M Mathad.							
55	Change of Branch	Santhosh S Bagoor							
56	4BD17CV166	Sujith. R							
57		Rohith. A							
58	Change of Branch	Kiran. M. M							
59		Suraj. N. Naikar.							
60		Murugharajendra. H. V							
61		Shree Harsha. J. R.							
		Initials of Teacher							
		Initials of H.O.D.							
		Initial of Principal							

PRINCIPAL
Sapthagiri Institute of Engineering & Technology
DAVANGERE

Class : III

Subject Code : 18CV32

Subject : Strength of Materials

Total No. of Classes : 94

Sl No.	USN	NAME	DATE	No. of Days Present	%	Test Marks I	Test Marks II	Test Marks III	Average	Remarks
62		Sandeep. B. N								
63		Shankar Rao Kulkarni. C.								
64		Ambika. H. T.								
65		Triveni. G.								
66		Pallavi. O.								
67		Harini. G. S.								
68		Veena B Bharamgouda								
69		Harsha. C. N.								
70		Harish. G. G.								
71		Trupthi S Balaikai								
72		Deepak. L								
73		Firdous Anjum. H.								

Initials of Teacher

Initials of H.O.D.

Initial of Principal

PRINCIPAL
Sahyadri Institute of Engineering & Technology
DAVANGERE.

LESSON PLAN

Subject : Subject Code : Class :

Period	Date	Topics Planned	Date	Topics Covered	Remarks
35	07.11.2020	Rankines Gordan's formula problems.	07.11.2020	Rankines Gordan's formula problems	covered
36	09.11.2020	Problems & Euler's Gordan's eqn.	09.11.2020	Problems & Euler's Gordan's eqn.	covered
37	11.11.2020	Module: 2 Compound Stress Introduction	11.11.2020	Module: 2 Compound Stress Introduction	covered.
38	12.11.2020	General two dimensional Stress System Principal Stress & Planes	12.11.2020	General two Dimensional Stress System Principal Stress & Planes	covered
39	13.11.2020	Problems on principal Stress & Planes	13.11.2020	Problems on Principal Stress & Planes	covered.
40	18.11.2020	Problems on Principal Stress & planes	18.11.2020	Problems on Principal Stress & Planes	covered
41	19.11.2020	Module: 3 Shear Force & Bending Moment Introduction	19.11.2020	Module: 3 Shear Force & Bending Moment : Introduction	covered.
42	21.11.2020	Types of Beams, Loading supports,	21.11.2020	Types of Beams, Loading supports	covered
43	23.11.2020	Simply supported Beam with Point load & eccentric loading with Problems	23.11.2020	Simply supported Beams with Point load & eccentric loading with problems	covered.
44	24.11.2020	Simply supported Beam with UDL with Problems	24.11.2020	Simple Supported Beams with ude with Problems	covered
45	25.11.2020	simply supported Beam with Problems	25.11.2020	simply supported Beam	covered
46	26.11.2020	Problems on simply supported Beam with Different loading condition	26.11.2020	Problems on simply supported Beam	covered
47	28.11.2020	Problems	28.11.2020	Problems	covered
48	30.11.2020	overhanging beam Derivation for with Different loading	30.11.2020	overhanging beams with different loading conditions	covered
49	1/12/2020	Problems	1/12/2020	problems	covered
50	2/12/20	Problems	2/12/20.	Problems	covered
51	3/12/20	cantilever beam with Different loading conditions	3/12/20.	Cantilever beams with different loading conditions	covered.

LESSON PLAN

Period	Date	Topics Planned	Date	Topics Covered	Remarks
52	14/12/20	Problems	14/12/20	Problems.	covered
53	15/12/20	module 4 Bending stress Introduction	15/12/20	Bending shear stress modulus of rigidity Introduction.	covered.
54	16/12/20	Derivation an equation of Bending Stress $\frac{m}{I} = \frac{E}{R} = \frac{b}{y}$	16/12/20	Derivation an equation Bending stress $\frac{m}{I} = \frac{E}{R} = \frac{b}{y}$	covered
55	21/12/20	Problem on Bending Stress	21/12/20	Problem on Bending stress	covered.
56	22/12/20	Problem on Bending Stress	22/12/20	Problem on Bending Stresses	covered.
57	23/12/20	Problem on Bending stress.	23/12/20	Problem on Bending stress	covered.
58	26/12/20	Deflection of Beams Modulus	26/12/20	Deflection of Beams	covered
59	28/12/20	Derivation of Beams. simply supported Beam with point.	28/12/20	Derivation of Beams simply supported Beams with point	covered
60	29/12/20	UDL UDV Problems	29/12/20	UDL, UVL problems	covered

Text Books :

1. B. S. Basavarajaiah, P. Mahadevappa. Strength of Material in S.I units University Press (India).
2. R Subramanian. Strength of Material latest edition.

Reference Books :

1. R. K. Bansal, A Text book of Strength of Materials. 4th edition Laxmi Publication. 2010.
2. D. H. Young. S. P. Timoshenko. "elements of Strength of Materials.
3. S. Ramamrutham. Strength of Materials.
4. S. S. Bhavikatti. by Strength of Materials.
5. .....

Signature of Faculty

HOD

TUTORIAL CLASSES

Date	Topics Discussed	Remarks
61	Problems on deflection	covered
62	Problems on deflection	covered.
63	Problems on deflection	covered
64	Problems on deflection	covered.
65	Problems on deflection	covered.
66	Problem on deflection	covered.
67	Module: 2 [For Diploma] Thick & Thin cylinders Derivations of hoop stress & longitudinal stress	covered
68	Problems on same	covered
69	Problems on Thick cylinders	covered
70	Thick cylinders Derivations	covered
71	Problems on Thick cylinders	covered
72	Problems on thick cylinders	

Test	Date	Class Strength	No. of Students Appeared	No. of Students Scored < 15	Signature of the HOD
T1	24/10/20	70	70	0	
T2	07.12.2020	70	70	0	
T3	22.02.2021	70	67	50	

LESSON PLAN

Subject: Basic surveying Subject Code: L8CVES Class: IInd B

Period	Date	Topics Planned	Date	Topics Covered	Remarks
1	10/9/20	Module: 1. Definition of surveying objectives & Importance	10/9/20	Module: 1. Definition of surveying objectives & importance	covered
2	14/9/20	Classifications of surveying.	14/9/20	Classification of surveying	covered
3	15/9/20	Principles of surveying	15/9/20	Principles of surveying	covered
4	16/9/20	Applications of surveying unit of measurement	16/9/20	Applications of surveying unit of measurements	covered
5	29/9/20	Surveying measurement errors, types of errors precisions &	21/9/20	surveying measurement errors, types of error, precision	covered
6.	23/9/20	Accuracy, classification of maps, Map & Numbering	23/9/20	Accuracy, classification of maps, Maps & Numbering	covered.
7	28/9/20	Measurement of Horizontal Distances: Measuring tape & types, measurement using tapes, Tapering	28/9/20	Measurement of Horizontal Distances measuring tape measurement using tapes	covered
8	30/9/20	Level ground. & Direct Ranging & In Direct Ranging	30/9/20	Level ground. & Direct ranging & Indirect ranging.	covered
9	1/10/20	Sloping ground Direct & Indirect Ranging	1/10/20	sloping ground by Direct & Indirect ranging.	covered
10	05/10/20	EDM, basic principles Booking of tape survey work	05/10/20	EDM, basic principles & Booking of tape survey work	covered
11	07/10/20	conventional symbols, obstacles in tape surveying	07/10/20	conventional symbols, obstacles in tape surveying	covered
12	08/10/20	Problems	08/10/20	Problems	covered.
13	12/10/20	Module: 4 Plane table surveying accessories	12/10/20	Module: 4 Plane table surveying accessories	covered
14	14/10/20	Setting up the plane table surveying	14/10/20	Setting up the plane table surveying	covered
15	15/10/20	methods of Plane table surveying Radiation	15/10/20	Methods of plane table surveying Radiation	covered
16	21/10/20	Intersection method. Traversing Advantages & Disadvantages Plane table surveying	21/10/20	Intersection method Traversing Advantages & Disadvantages Plane Table surveying	covered
17	22/10/20	Resection Two point Problem, Three Point Problem	22/10/20.	Resection - Two Point Problem & Three Point Problem	Covered

LESSON PLAN

Subject : Basic surveying Subject Code : 18CV35 Class : 3rd B

Period	Date	Topics Planned	Date	Topics Covered	Remarks
18	20.10.20	Three Point Problem ~~Ex 7~~	20.10.20	Three Point Problem	covered
19	21.10.20	Module:5. Areas & volume Different Area - methods of Area calculation	21.10.20	Module:5. Areas & volume. Introduction	Covered
20	24.10.20	Offsets at Regular intervals.	24.10.20	Offsets at Regular Intervals.	covered
21	05.11.20	Area from co-ordinates with problems.	05.11.2020	Area from co-ordinates with Problems	covered
22	9.11.20	Problem on Area by Different methods	9.11.2020	Problem on Areas by Different methods	covered
23	11.11.20	Volume: Different methods Problem on volume	11.11.2020	volume: Different methods & problem on volume	covered
24	18.11.2020	Problem on volume.	18.11.2020	Problems on volume	covered
25	19.11.2020	Module: 2 Compass Surveying Introduction	19.11.2020	Module: 2 Compass surveying Introduction	covered
26	23.11.2020	Definition of Bore Bearing Back Bearing, WCB, QB problems	23.11.2020	Definition of Bore Bearing Back Bearing, WCB, QB Problems	covered
27	25.11.2020	Magnetic Dip & Declination with Problems Prismatic compass, Surveyor compass with comparison	25.11.2020	magnetic dip & Declination with Problem. Prismatic compass. Surveyor compass with comparison.	covered
28	26.11.2020	Problem on Interior angles	26.11.2020	Problem on Interior angles (Included angle)	covered
29	02/12/2020	Local attraction Introduction Problem	02/12/2020	Local attraction Problem	covered
30	04/12/2020	Problem on local attraction	04/12/2020	Problem on local attraction	covered
31	16/12/2020	Traverse : computation Introduction	16/12/2020	Traverse computation	covered
32	21/12/2020	1. Dependent co-ordinates 2. Independent co-ordinates 3. closing error with Problem	16/12/2020	1. Dependent co-ordinates 2. Independent co-ordinates 3. closing error with Problem	covered
33	23/12/2020	1. Bowditch rule 2. Transit rule with Problem	23/12/2020	Problem	covered
34	28/12/2020	omitted measurements problem	28/12/2020	omitted measurement with Problem	covered

LESSON PLAN

Subject: Basic Surveying Subject Code: 18CV35 Class: 2nd B

Period	Date	Topics Planned	Date	Topics Covered	Remarks
25	30.12.20	Module: 3 levelling: Basic definitions, methods of levelling.	30/12/20	Module: 3 levelling: Basic definitions, methods of levelling	covered
26	31.12.20	Dumpy level, Auto level, digital levelling & laser levelling	31.12.20	Dumpy level, Auto level, digital levelling & laser levelling	covered
27	4.1.21	Curvature and refraction corrections,	4.1.21	Curvature & refraction corrections	covered
28	5.1.21	Booking & reductions of levels. Problems	5.1.21	Booking & reductions of levels & Problems	covered
29	7.1.21	Problems on levelling	7.1.21	Problems on levelling	covered
30	13.1.21	Problems on levelling Difference levelling	13.1.21	problems on Difference levelling	covered
31	17.1.21	Problems on Difference levelling	17.1.21	Problems on Difference levelling	covered
32	21.1.21	Profile levelling with Problems	21.1.21	Profile levelling with Problems	covered
33	01.2.21	fly levelling with Problems	01.2.21	fly levelling with Problems.	covered
34	3.2.2021	Reciprocal levelling	3.2.2021	Reciprocal levelling	covered
35	4.2.2021	problems on Reciprocal levelling	4.2.2021	Problems on Reciprocal levelling	covered
36	10.2.2021	module: 4 Plane table surveying accessories, setting up plane table surveying	10.2.2021	module: 4 Plane table surveying accessories setting up plane table surveying	covered
37	11.2.2021	methods of plane table surveying	11.2.2021	methods of plane table surveying	covered.
38	15.2.2021	Advantages & Disadvantages of plane table surveying Resection of two-point problems, three-point problems	15.2.2021	Advantages & Disadvantages of plane table surveying Resection of two-point three point Problems	covered
39	17.2.2021	Three point problems	17.2.2021	Three point Problems	covered.
50.	17.2.2021	module: 5 Area & Volume Area - methods of Area calculation, effect of Regular Intervals.	17.2.2021	module: 5 Area & Volume Area - methods of area calculation, effect of Regular Intervals	covered
51	18.2.2021	Area from co-ordinates with Problems, by Different methods, Volumes: Different methods	18.2.2021	Area from co-ordinates with Problems, by different methods, Volumes Different methods.	covered.

LESSON PLAN

Period	Date	Topics Planned	Date	Topics Covered	Remarks

Text Books :

1. B.C. Punmia, "Surveying Vol-I". Lakmi Publications Pvt. Limited New Delhi - 2015.
2. Kanetkar T.P. & S.V. Kulkarni. Surveying & Leveling.

Reference Books :

1. S.K. Duggal "Surveying Volume 1".
2. K.R. Arora. Surveying Volume 1.
3. R. Subramanian. Surveying & Leveling.
4.
5.

Signature of Faculty

HOD

TUTORIAL CLASSES

Date	Topics Discussed	Remarks

Test	Date	Class Strength	No. of Students Appeared	No. of Students Scored < 15	Signature of the HOD
T1	23.10.2020	67	67	00	
T2	09.12.2020	67	67	00	
T3	23.02.2021	67	67	00	

TIME TABLE RAGHU M.E

Day / Time	1 8.00 - 9.00	2 9.00 - 10.00	10.00 - 10.30	3 10.30 - 11.30	4 11.30 - 12.30	12.30 - 2.00	5 2.00 - 3.00	6 3.00 - 4.00	7 4.00 - 5.00
MONDAY	18CV32 - A		SHORT BREAK			LUNCH BREAK	18CV35 - B		18CVL57 - T (B)
TUESDAY		18CV32 - A							
WEDNESDAY	18CV35 - B				18CV32 - B		← 18CVL57 - A3 (MERT SH)		
THURSDAY		18CV35 - B		18CV32 - A			← 18CVL57 - B1 (MERT&RN)		
FRIDAY		← 18CVL38 A1 (MER+CPA)							
SATURDAY		18CV32 - A							

3rd A - Section
= Strength of Materials
3rd B - Section
= Basic Surveying
18CVL57 - T (B)
= Surveying Practice
18CVL57 - B1 & A3
- Surveying Practice.
18CVL38 - A1
Building Materials Lab

Sign. of the Staff

Sign. of the HOD

PRINCIPAL
Sign. of the Principal
Appaji Institute of Engineering & Technology
DAVANGERE.

B. E. CIVIL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – III

BASIC SURVEYING

Course Code	**18CV35**	CIE Marks	40
Teaching Hours/Week(L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students to;

1. Understand the basic principles of Surveying
2. Learn Linear and Angular measurements to arrive at solutions to basic surveying problems.
3. Employ conventional surveying data capturing techniques and process the data for computations.
4. Analyze the obtained spatial data to compute areas and volumes and draw contours to represent 3D data on plane figures.

Module-1

Introduction: Definition of surveying, Objectives and importance of surveying. Classification of surveys. Principles of surveying. Units of measurements, Surveying measurements and errors, types of errors, precision and accuracy. Classification of maps, map scale, conventional symbols, topographic maps, map layout, Survey of India Map numbering systems.

Measurement of Horizontal Distances: Measuring tape and types. Measurement using tapes, Taping on level ground and sloping ground. Errors and corrections in tape measurements, ranging of lines, direct and indirect methods of ranging, Electronic distance measurement, basic principle. Booking of tape survey work, Field book, entries, Conventional symbols, Obstacles in tape survey, Numerical problems.

Module-2

Measurement of Directions and Angles: Compass survey: Basic definitions; meridians, bearings, magnetic and True bearings. Prismatic and surveyor's compasses, temporary adjustments, declination. Quadrantal bearings, whole circle bearings, local attraction and related problems

Traversing: Traverse Survey and Computations: Latitudes and departures, rectangular coordinates, Traverse adjustments, Bowditch rule and transit rule, Numerical Problems.

Module-3

Leveling: Basic terms and definitions, Methods of leveling, Dumpy level, auto level, digital and laser levels. Curvature and refraction corrections. Booking and reduction of levels. Differential leveling, profile leveling, fly leveling, check leveling, reciprocal leveling.

Module-4

Plane Table Surveying: Plane table and accessories, Advantages and limitations of plane table survey, Orientation and methods of orientation, Methods of plotting – Radiation, Intersection, Traversing, Resection method, Two point and three point problems, Solution to two point problem by graphical method, Solution to three point problem Bessel's graphical method, Errors in plane table survey.

Module-5

Areas and Volumes: Measurement of area by dividing the area into geometrical figures, area from offsets, mid ordinate rule, trapezoidal and Simpson's one third rule, area from co-ordinates, introduction to planimeter, digital planimeter. Measurement of volumes- trapezoidal and prismoidal formula.

Contouring: Contours, Methods of contouring, Interpolation of contours, contour gradient, characteristics of contours and uses.

Course outcomes: After a successful completion of the course, the student will be able to:

1. Posses a sound knowledge of fundamental principles Geodetics
2. Measurement of vertical and horizontal plane, linear and angular dimensions to arrive at solutions to basic surveying problems.
3. Capture geodetic data to process and perform analysis for survey problems]
4. Analyse the obtained spatial data and compute areas and volumes. Represent 3D data on plane figures as contours

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. B.C. Punmia, "Surveying Vol.1", Laxmi Publications pvt. Ltd., New Delhi –2009.
2. Kanetkar T P and S V Kulkarni , Surveying and Leveling Part I, Pune VidyarthiGrihaPrakashan,1988

Reference Books:

1. S.K. Duggal, "Surveying Vol.1", Tata McGraw Hill Publishing Co. Ltd. New Delhi.2009.
2. K.R. Arora, "Surveying Vol. 1" Standard Book House, New Delhi. –2010
3. R Subramanian, Surveying and Leveling, Second edition, Oxford University Press, NewDelhi
4. A. Bannister, S. Raymond , R. Baker, "Surveying", Pearson, 7th ed., NewDelhi

Course Title	Basic Surveying (18CV35)
CO	Statement
18CV35.1	**Explain** the fundamental concepts of surveying
18CV35.2	**Apply** the conventional and advanced methods for measuring horizontal distance
18CV35.3	**Apply** the concept of latitude and departure for the adjustment of compass closed traverse
18CV35.4	**Predict** the topography of the ground profile using the concepts of levelling and contours
18CV35.5	**Solve** two and three point problems in plane table surveying
18CV35.6	**Compute** areas and volumes for civil engineering projects

Course Title	Basic Surveying											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
18CV35.1	2	2	-	1	-	-	-	-	-	-	-	2
18CV35.2	2	2	-	1	-	-	-	-	-	-	-	2
18CV35.3	2	2	-	1	-	-	-	-	-	-	-	2
18CV35.4	2	2	-	1	-	-	-	-	-	-	-	2
18CV35.5	2	2	-	1	-	-	-	-	-	-	-	2
18CV35.6	2	2	-	1	-	-	-	-	-	-	-	2
Average	2	2		1								2

CO	PSO1	PSO2
18CV35.1	2	2
18CV35.2	2	2
18CV35.3	2	2
18CV35.4	2	2
18CV35.5	2	2
18CV35.6	2	2
Average	2	2

Bapuji Educational Association ®
Bapuji Institute of Engineering and Technology, Davangere–577 004
Department of Civil Engineering

Result Analysis **Academic Year: 2020-21 ODD SEM**

Name of the Faculty		Raghu M E		Academic Year : 2020-21 ODD SEM	
Sl. No.	Subject Title	Subject Code	Total No. of students appeared for the exam	No. of Students passed	Pass Percentage
1	Basic Surveying	18CV35	67	42	63

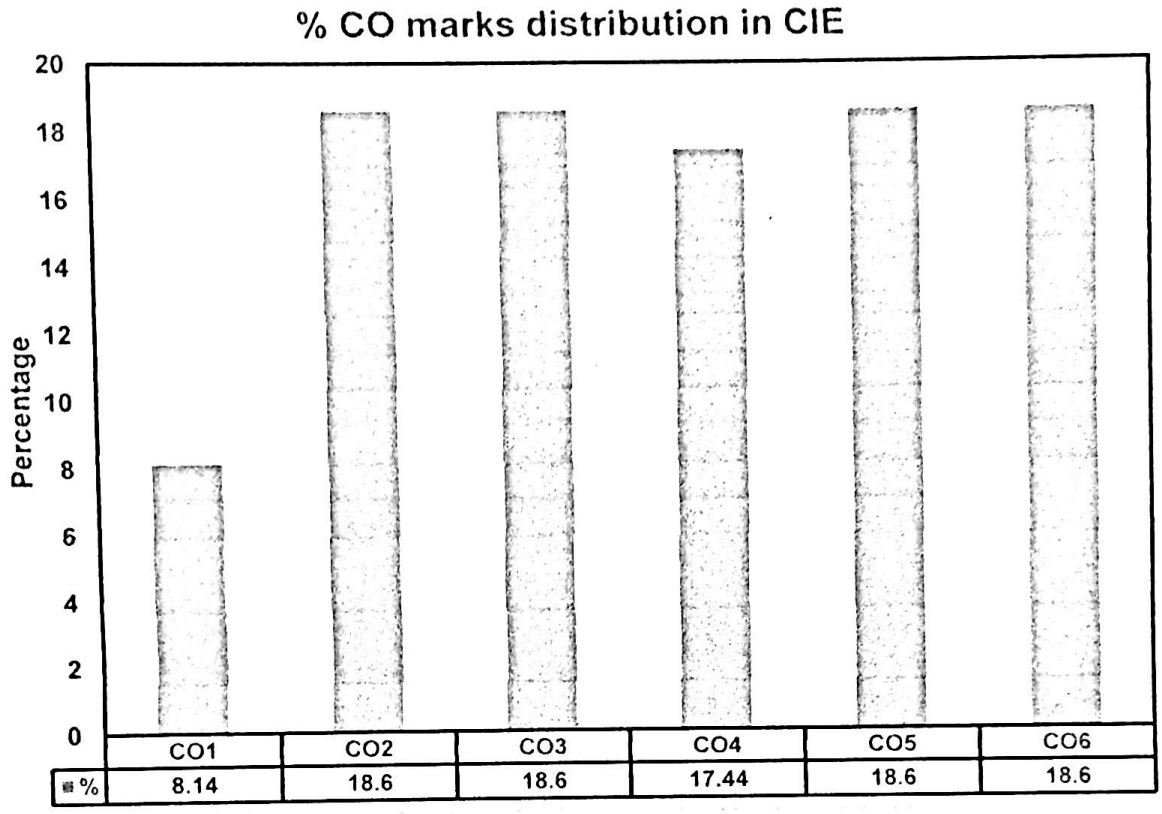
Staff in Charge

HOD Civil

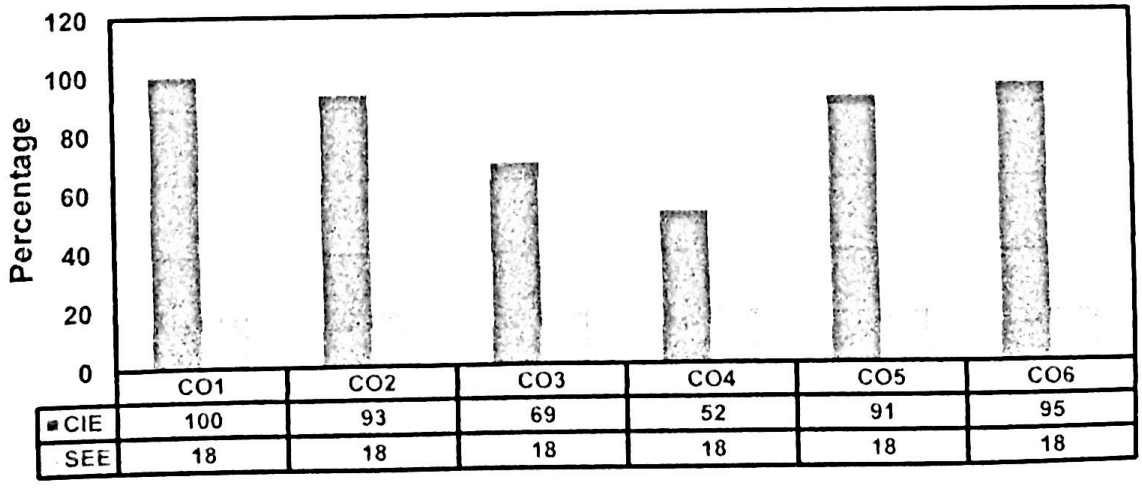
Bapuji Educational Association ®
Bapuji Institute of Engineering and Technology, Davangere–577 004
Department of Civil Engineering

Attainment

Basic Surveying 18CV35 ODD SEM 2020-2021

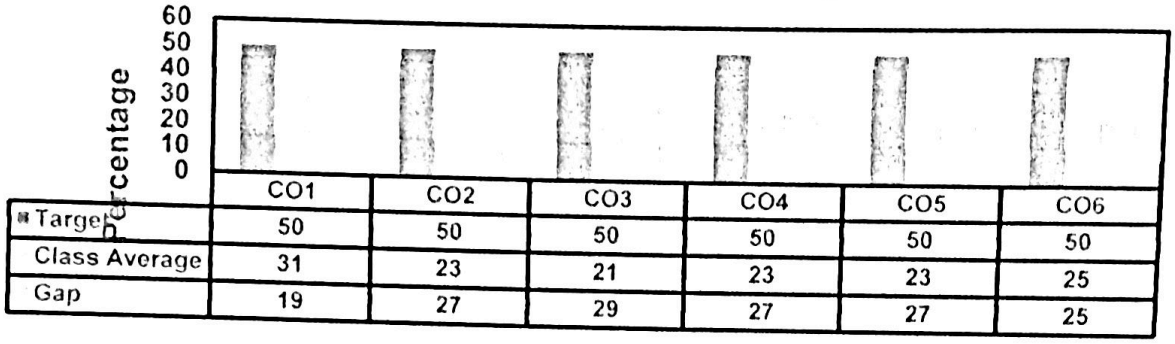


	CO1	CO2	CO3	CO4	CO5	CO6
%	8.14	18.6	18.6	17.44	18.6	18.6



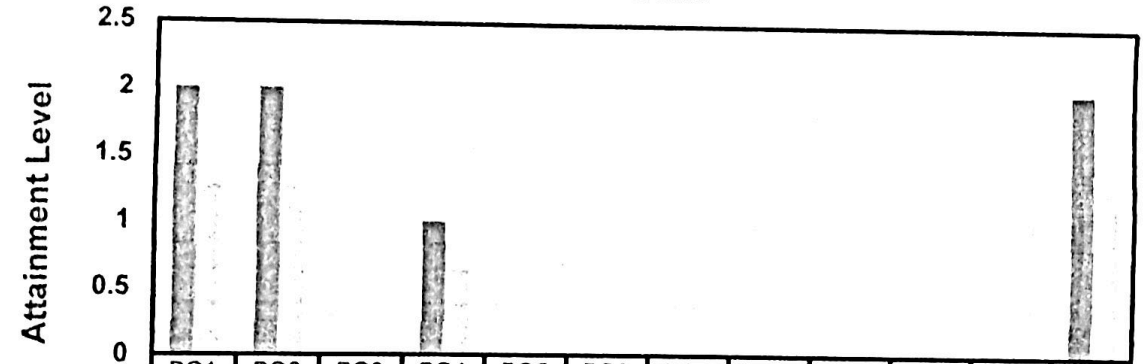
	CO1	CO2	CO3	CO4	CO5	CO6
CIE	100	93	69	52	91	95
SEE	18	18	18	18	18	18

Target vs Class Average

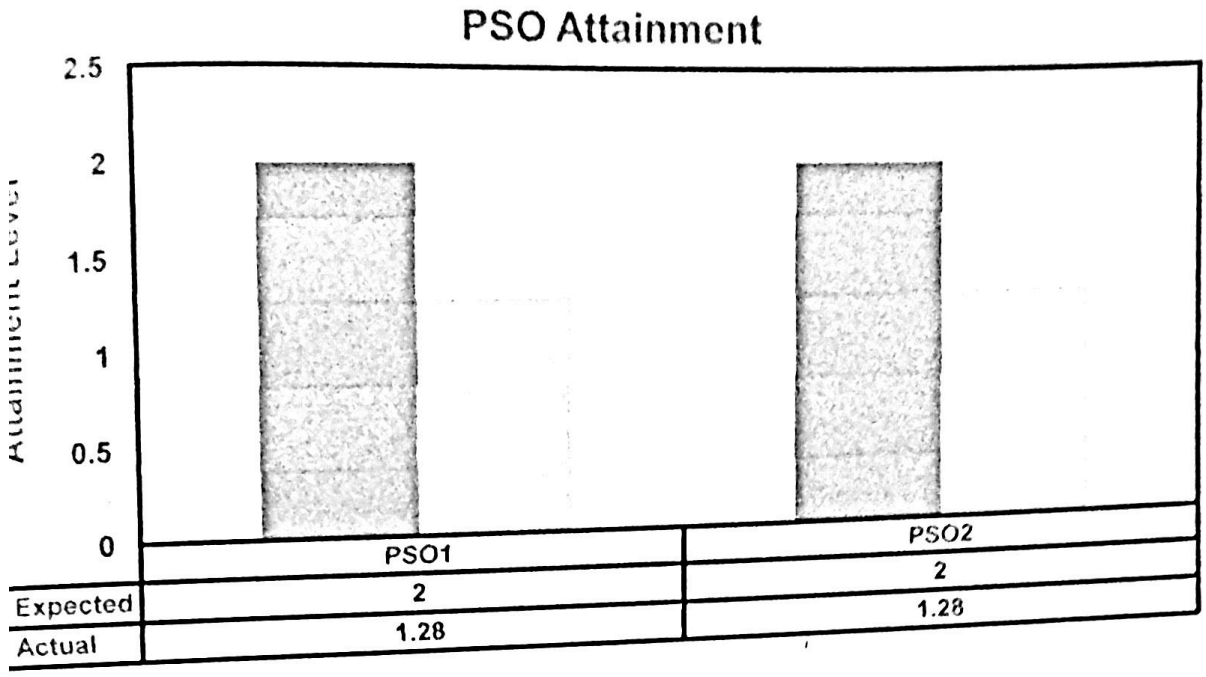


	CO1	CO2	CO3	CO4	CO5	CO6
Target	50	50	50	50	50	50
Class Average	31	23	21	23	23	25
Gap	19	27	29	27	27	25

PO Attainment



	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Expected	2	2	0	1	0	0	0	0	0	0	0	2
Actual	1.28	1.28	0	0.64	0	0	0	0	0	0	0	1.28


PSO Attainment
Attainment Level
2.5
2
1.5
1
0.5
0
PSO1
PSO2
Expected
2
2
Actual
1.28
1.28

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Department of Civil Engineering

Assignment

Date | 25 | 10 | 20

Assignment No.	01	Maximum Marks	10
Course/Subject Title	Basic Surveying	Course/Subject Code	18CV35
Semester	III	Scheme	CBCS – 18

Course Outcome Statements : After the successful completion of the course, the students will be able to Outcome Statements	
18CV35.1	Explain the fundamental concepts of surveying
18CV35.2	Apply the conventional and advanced methods for measuring horizontal distance
18CV35.3	Apply the concept of latitude and departure for the adjustment of compass closed traverse
18CV35.4	Predict the topography of the ground profile using the concepts of levelling and contours
18CV35.5	Solve two and three point problems in plane table surveying
18CV35.6	Compute areas and volumes for civil engineering projects

Last date for submission	30	11	2020

Note :

Q. No.	Question	Marks	RBT Level	CO
	Module -1			
1	Define Surveying. Explain the basic principles of surveying? Mention the classification of surveying.		L1&L2	CO1
2	What is meant by tape correction and Explain the different types of tape correction.		L1&L2	CO1
3	With neat sketches show conventional symbols used in surveying.		L1&L2	CO1
4	Mention the different types of obstacles in surveying. A steel tape is 30m long at 18° c. when laid horizontally on the ground. Its sectional area is $2mm^2$. Its weight is 12.36N and co-efficient of expansion is 35×10^{-7} /°c. The tape is stretched over three supports at the same level and at equal intervals. Calculate the actual length. When the temperature and pull applied during measurement are 25°c and 400 N. Assume E = 1.77×10^5 N/mm^2		L2&L3	CO2
5	Define Ranging. Explain indirect or Reciprocal Ranging with Sketch. Two Stations P and Q on the main Survey line were taken on the opposite sides of a pond on the right of PQ a line PR=210m long was laid down and another line PS=260m long was laid down on the left of PQ. The points R, Q and S were on the same Straight line. The measured lengths of RS and QS were 85m and 75m respectively. Find the length of PQ.		L2&L3	CO2
	Module -4			
6	Define plane table surveying. Explain the accessories of a plane table survey.		L2	CO5
7	What are the different methods of plane table survey? Explain the intersection method of plane table surveying.		L2	CO5
8	List the advantages and disadvantages of plane table surveying. Mention the errors in plane table survey.		L2	CO5
9	State three point problem in plane table survey. Explain Bessel's graphical solution for the three point problem.		L2	CO5
10	State and Explain two point problem in plane table survey.		L2	CO5

RBT (Revised Bloom's Taxonomy) Levels : Cognitive Domain		
L1 : Remembering	L2 : Understanding	L3 : Applying
L4 : Analysing	L5 : Evaluating	L6 : Creating

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Department of Civil Engineering

Assignment -02

Date	25	11	20

Assignment No.	**02**	**Maximum Marks**	**10**
Course/Subject Title	**Basic Surveying**	**Course/Subject Code**	**18CV35**
Semester	**III**	**Scheme**	**CBCS – 18**

Course Outcome Statements : After the successful completion of the course, the students will be able to Outcome Statements	
18CV35.1	Explain the fundamental concepts of surveying
18CV35.2	Apply the conventional and advanced methods for measuring horizontal distance
18CV35.3	Apply the concept of latitude and departure for the adjustment of compass closed traverse
18CV35.4	Predict the topography of the ground profile using the concepts of levelling and contours
18CV35.5	Solve two and three point problems in plane table surveying
18CV35.6	Compute areas and volumes for civil engineering projects

Note :

Q. No.	Question	Marks	RBT Level	CO
	Module -5			
1	Explain the general methods of Determining area		L2	6
2	A series of offsets were taken from a chain line to a curved boundary line at intervals of 15m in the following order 0, 2.65, 3.8, 3.75, 4.65, 3.6, 4.95, 5.85m. Compute the area between the chain lines. The curved boundary and the end offset by 1) Average ordinate rule 2) Trapezoidal rule 3) Simpsons rule		L3	6
3	The following perpendicular offsets were taken from a chain line to hedge. Chainage (M): 0, 15, 30, 45, 60, 70, 80, 100, 120, 140 Offsets (M): 7.6, 8.5, 10.7, 12.8, 10.6, 9.5, 8.3, 7.9, 6.4, 4.4 Calculate the area between survey line, the hedge and end offsets by 1)Trapezoidal rule 2) Simpson's rule		L3	6
4	The latitudes and departures of the lines of a closed traverse ABCDA are given. Compute the area by independent co–ordinates method. AB: -164.50, +162.10 BC: +217.80, +59.80 CD: +168.10, -105.60 DA: -221.40, -116.30		L3	6
5	A Railway embankment 400 m long is 12m wide at the formation level and has side slope of 2 to 1. The ground levels at every 100 m along the centre line are as under Distance: 0, 100, 200, 300, 400 RL: 204.8, 206.2, 207.5, 207.2, 208.3 The formation level at zero chainage is 207.00 and the embankment has a rising gradient of 1 in 100. The ground is level across the centre line. Calculate the volume of earthwork.		L3	6
6	Define Contouring. Explain the Different Characteristics of contours.		L2	6
7.	Explain the different methods of contouring.		L2	6
8.	Explain briefly planimeter with uses.			
	Module -2			

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Department of Civil Engineering

Assignment -02

Date | 25 | 11 | 24

Note :

Q. No.	Question	Marks	RBT Level	CO
9	Distinguish between a) True meridian and true bearing b) Magnetic meridian and magnetic bearing c) Whole circle bearing and quandrantal bearing d) Fore bearing and back bearing. e) Find the back bearing of the following lines given that the fore bearing of line. 1) 60°45' 2) 210° 40' 3) S30°30'E 4) N45°30'W f) Convert the whole circle bearing to quandrantal bearings 22°30' 2) 170°12' 3) 211°54'4) 327°24'		L2 &L3	3
10	Differentiate between Prismatic compass and surveyor compass.		L2	3
11	The following are the bearings of a closed traverse using a prismatic compass. Compute the included angles. Is there any error in the measurement of bearings? Line: AB | BC | CD | DE | EF | FA Bearings: 37°30' | 92° | 151°30' | 221°15' | 283° | 330°15'		L3	3
12	Define Magnetic Declination and Dip of the magnetic needle.		L2	3
13	On an old map, a line was drawn to magnetic bearing of 320°30', when the declination was 3°30' W. Find the present bearing of the line, if the declination is 4°15 E.		L3	3
14.	Following are the observed magnetic bearings of a closed traverse. Line: PQ | QR | RS | SP Fore bearings: 124°30' | 68°15' | 310°30' | 200°15' Back Bearings: 304°30' | 246°00' | 135°15' | 17°45'		L3	3
15.	Define the following a) Latitude and Departure b) Dependent Co-ordinates and In Dependent Co-ordinates. c) Closing error		L3	3
16.	The following observations were taken in a closed traverse. Calculate a) The Dependent Co-ordinates b) The and In Dependent Co-ordinates of B, C and D, if the coordinates of A are 200,200. Line: AB | BC | CD | DA Length , M: 156.2 | 318.9 | 88.4 | 304.0 Bearings: 140°12' | 41°12' | 312°42' | 233°42'		L3	3
17.	Explain the following a) Bowditch's method b) Transit Method		L3	3
18.	The following Data pertains to a closed traverse. Adjust it by Bowditch's method and Transit Method. Line: AB | BC | CD | DE | EA Length , M: 70 | 80 | 43 | 38 | 115 Latitude: 21.500 | -80.755 | -41.000 | -14.250 | +114.150 Departure: -65.450 | -5.250 | +13.550 | +35.150 | +22.3015		L3	3
19.	Explain Omitted measurement			
20.	The table below gives the length and bearings of the lines of a closed traverse ABCDE, the length and bearing of BC having been omitted. Calculate the length and bearing of BC.		L3	3

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Department of Civil Engineering

Assignment -02

Date	25	11	20

Note :

Q. No.	Question			Marks	RBT Level	CO
	Line	Length , M	Bearings			
	AB	204	87°30'			
	BC	?	?			
	CD	187	280°			
	DE	192	210°30'			
	EA	87.85	180°28'			

Last date for submission	30	12	2020

RBT (Revised Bloom's Taxonomy) Levels : Cognitive Domain		
L1 : Remembering	L2 : Understanding	L3 : Applying
L4 : Analysing	L5 : Evaluating	L6 : Creating

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Bapuji Institute of Engineering and Technology, Davangere-577 004
Department of Civil Engineering

USN										

Course/Subject Title	Basic Surveying	Course/Subject Code	18CV35
Semester	III B	Scheme	CBCS – 18
Date	23/10/2020	CIE No.	IA -1
Time	2:00-3:00 PM	Max. Marks	30

Course Outcome Statements : After the successful completion of the course, the students will be able to	
18CV35.1	Explain the fundamental concepts of surveying
18CV35.2	Apply the conventional and advanced methods for measuring horizontal distance
18CV35.3	Apply the concept of latitude and departure for the adjustment of compass closed traverse
18CV35.4	Predict the topography of the ground profile using the concepts of levelling and contours
18CV35.5	Solve two and three point problems in plane table surveying
18CV35.6	Compute areas and volumes for civil engineering projects

Note: ANSWER ANY ONE QUESTION FROM PART A AND FOUR QUESTIONS FROM PART B.

Q. No.	Questions	Marks	RBT Level	CO
	Part -A			
1	Define Surveying. Explain the basic principles of surveying?	6	L1&L2	1
2	Explain briefly the classification of surveying.	6	L1&L2	1
	Part -B			
3	What is meant by tape correction and Explain the different types of tape correction.	6	L1&L2	2
4	Mention the different types of obstacles in surveying.	6	L2&L3	2
5	Define Ranging. Explain indirect Method of ranging and method of measuring horizontal distance on sloping ground.	6	L2&L3	2
6.	A 20m steel tape was standardised on flat ground at a temperature of 20°C and under a pull of 150N. The tape was used as catenary at a temperature of 30°C and under a pull of 100N. The cross sectional area of tape is $2mm^2$, and its total weight is 4N. The young's modules and coefficient of linear expansion of steel are 210GPa and $11*10^{-6}$/°C. Find the correct horizontal distance.	6	L3	2
7	Two Stations P and Q on the main Survey line were taken on the opposite sides of a pond on the right of PQ, a line PR=210m long was laid down and another line PS=260m long was laid down on the left of PQ. The points R, Q and S were on the same Straight line. The measured lengths of RQ and QS were 85m and 75m respectively. Find the length of PQ.	6	L2&L3	2

RBT (Revised Bloom's Taxonomy) Levels		
L1 : Remembering	L2 : Understanding	L3 : Applying
L4 : Analysing	L5 : Evaluating	L6 : Creating

23/10/2020
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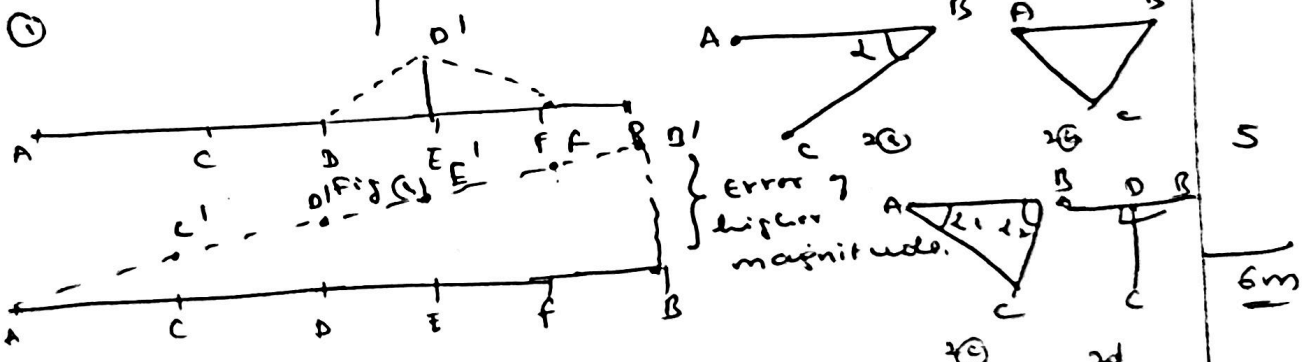
Bapuji Educational Association ®
Bapuji Institute of Engineering and Technology, Davangere–577 004
Department of Civil Engineering

Scheme of Valuation

Course/Subject Title	Basic Surveying	Course/Subject Code	18CV35
Semester	III B	CIE No.	01
Date	23/10/2020	Max. Marks	30

Q.	Solution	Marks
	Answer any one question from Part A & four question from Part B.	1
	Part A	
1.	Definition of surveying : – 1m Basic Principle : → 1. To work from whole to the part 2. location of a point by two observations	
	 	5
	Each principle with fig - 2 ½ × 2 = 5m	6m
2.	(0.5) Classification of surveying 1. Based on Instrument. 2. Methods of surveying 3. object of surveying 4. Nature of field surveying } 4 × 1 ½ =	6m.
	Part B	
③	Definition of tape correction. —— Explanation of tape correction any five ——	1m 5m
		6m.
4.	Types of obstacles in surveying.	

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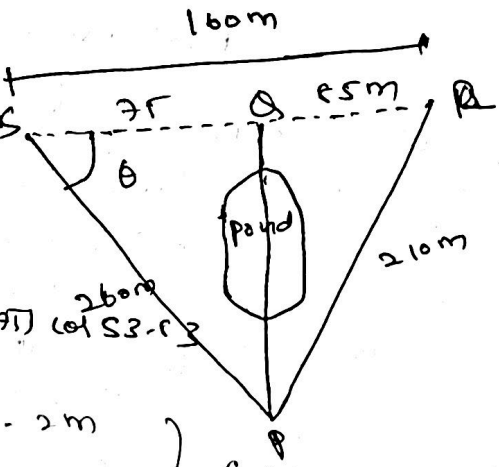
Department of Civil Engineering

Scheme of Valuation

Q.	Solution	Marks
	③ obstsclein rangiy ⑥ obsticlein chainiy ⑥ obstsclein both chainiy & rangiy with his fi.	3×2 = 6m
⑤	Definition of Rangiy —	1m
	In Direct method of Rangiy over a sloping ground 1. By measuring slope with clinometer. 2. By applying hypothenusal allowance. & any point with his 3. By knowing difference in level b/w points.	5m 6m.
06	① $C_t = \alpha[T - T_0]L$ — 1m $C_t = 0.0022m$ (+ve) — 1m L = 20m, T_0 = 20°C, P = 10kN, T = 30°C, P = 10kN, A = 2mm², W = 10kN, E = 2.1×10⁵ N/mm², α = 11×10⁻⁶/°C — 1m	
	2. $C_p = \left[\frac{P - P_0}{AE}\right]L = 0.0023m$ +ve — 1m	
	3. $C_s = \frac{-(WL)}{AE}$ $C_s = 0.0013m$ −ve — 1m	
	Net correction = −0.0015 1m — 1m Corrected distance = 20 − 0.0015 1 = 19.9984m — 1m	6m
07	a) PSR. $PR^2 = SR^2 + SP^2 - [2 \times SR \times SP]\cos\theta$ $210^2 = 160^2 + 260^2 - [2 \times 160 \times 260]\cos\theta$ $\theta = 53.82°$	
	b) PSQ $PQ^2 = 260^2 + 75^2 - [2 \times 260 \times 75]\cos 53.82$ $PQ = 226.07m$	
	 Fig. 2m Q = 2m PQ = 2m 6m	2m 2m 2m 6m

Course Coordinator (Faculty in charge) 23.10.2020

Coordinator DQAC 23/10/2020

Program Coordinator (HOD, Civil) 23/10/2020

Bapuji Educational Association ®
Bapuji Institute of Engineering and Technology, Davangere–577 004
Department of Civil Engineering

USN										

Course/Subject Title	Basic Surveying	Course/Subject Code	18CV35
Semester	III B	Scheme	CBCS – 18
Date	09/12/2020	CIE No.	IA -II
Time	9:00-10:00 AM	Max. Marks	30

Course Outcome Statements : After the successful completion of the course, the students will be able to	
18CV35.1	**Explain** the fundamental concepts of surveying
18CV35.2	**Apply** the conventional and advanced methods for measuring horizontal distance
18CV35.3	**Apply** the concept of latitude and departure for the adjustment of compass closed traverse
18CV35.4	**Predict** the topography of the ground profile using the concepts of levelling and contours
18CV35.5	**Solve** two and three point problems in plane table surveying
18CV35.6	**Compute** areas and volumes for civil engineering projects

Note: ANSWER ANY ONE FULL QUESTION FROM EACH PART.

Q. No.	Questions	Marks	RBT Level	CO
	Part -A			
1a)	What are the different methods of plane table survey? Explain the intersection method of plane table surveying.	8	L2	5
1b)	List the advantages and disadvantages of plane table surveying. Mention the errors in plane table survey.	7	L2	5
	OR			
2a)	State three point problem in plane table survey. Explain Bessel's graphical solution for the three point problem.	8	L2	5
2b)	Define plane table surveying. Explain the accessories of a plane table survey.	7	L2	5
	Part -B			
3a)	Explain the general methods of Determining area	7	L2	6
3b)	The following perpendicular offsets were taken from a chain line to hedge. Chainage (M): 0, 15, 30, 45, 60, 70, 80, 100, 120, 140 Offsets (M): 7.6, 8.5, 10.7, 12.8, 10.6, 9.5, 8.3, 7.9, 6.4, 4.4 Calculate the area between survey line, the hedge and end offsets by 1)Trapezoidal rule 2) Simpson's rule	8	L3	6
	OR			
4a)	Explain the Different Characteristics of contours.	7	L2	6
4b)	A Railway embankment 400 m long is 12m wide at the formation level and has side slope of 2 to 1. The ground levels at every 100 m along the centre line are as under Distance: 0, 100, 200, 300, 400 RL: 204.8, 206.2, 207.5, 207.2, 208.3 The formation level at zero chainage is 207.00 and the embankment has a rising gradient of 1 in 100. The ground is level across the centre line. Calculate the volume of earthwork.	8	L3	6

RBT (Revised Bloom's Taxonomy) Levels		
L1 : Remembering	L2 : Understanding	L3 : Applying
L4 : Analysing	L5 : Evaluating	L6 : Creating

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Bapuji Institute of Engineering and Technology, Davangere–577 004
Department of Civil Engineering

Scheme of Valuation

Course/Subject Title	Basic surveying	Course/Subject Code	18CV35
Semester	IIIrd B.	CIE No.	02
Date	09/12/2020	Max. Marks	36

Q.	Solution	Marks
	Part: A.	
	Answer any one question from Each part.	
1(a)	Four methods of plane table surveying.	
	1. Radiation method. } 2m	8m
	2. Intersection method	
	3. Two Point Problem.	
	4. Three point Problem.	
	Explaination with fig of Intersection method. fig - 3m, Procedure - 5m	
1(b)	Advantages and Disadvantages.	
	Advantages.	3.5m
	1. Suitable for plotting small scale maps 7×1/2 =	
	2. Since plotting is done in the field, field book is not required.	
	3. As the surveyor has full view of the details while plotting. the omission of any detail is avoided	
	4. Instruments are simple and not much skill is required.	
	5. Plane table survey is generally more rapid and less costly	
	6. Plane table survey can be adopted even in magnetically disturbed area where compass survey is not possible.	
	7. errors in measurement & plotting can be easily detected	
	Disadvantages. 7/2 Each	
	1. Not very accurate.	3.5m
	2. Equipment is quite heavy. surveyor has to carry several accessories.	
	3. Difficult to plot the plan to a different scale at field	
	4. Plane table surveys is suitable for open country. data are not taken.	
	5. Sufficient practice is required to obtain an accurate plot.	
	6. Plane table Survey is not possible in wet climate & high winds.	

Course Coordinator (Faculty in charge)

Coordinator DQAC

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Department of Civil Engineering

Scheme of Valuation

Q.	Solution	Marks
2a	Three point problem Statement: location of plane table station on the paper by means of observations to three well defined points, whose positions have been already plotted. fig with explanation	Statement-2m fig - 2m explanation-4m 8m
2b	Plane table surveying - definitions - 1m 1. Alidade. 2. Plumbing fork. 3. Level tube. 4. Trough compass. 5. Plane table with stand. with Explanations 6m	7m 13m
3a	Part - B a) By compulsions based directly on field measurements b) By computation based on measured scaled from a map c) By mechanical method. planimeter	3m 3m 1m 7m
3b	Simpson's rule $A = \frac{d}{3}[(O_0+O_n) + 4(O_1+O_3+\dots+O_{n-1}) + 2(O_2+O_4+\dots+O_{n-2})]$ - 1m $A = 1230.8\ m^2$ - 4m Trapezoidal rule $A = (\frac{O_0+O_n}{2} + O_1 + O_2 + \dots + O_{n-1})d$ $A = A_1+A_2+A_3 = 1218\ m^2$ - 4m	5m
4a	Characteristics of contours Any 7 characteristics of contours with fig 1x7 = 7m Interpolation, Uniformity, Representation, Hill, V-shape, Saddle, Steepest slope, U-shape.	7m
4b	$A = (b+nh)h$ $b=12, n=2$. $A_1 = [12 + 2\times2.2\ 2.2) = 36.08\ m^2$ $A_2 = [12\times2\times1.8)\ 1.8] = 28.08\ m^2$ $A_3 = [(12\times2)\times1.5)\ 1.5] = 22.50\ m^2$ $A_4 = (12\times2)\times2.8)\ 2.8) = 49.28\ m^2$ $A_5 = [(12\times2)\times2.7)\ 0.7) = 46.98\ m^2$ Volume of prismoidal rule $V = \frac{d}{3}[A_1+A_n) + 4(A_2+A_4+\dots A_{n-1}) + 2(A_3+A_5+\dots A_{n-2})]$ $V = 14.28\ m^3$ - 3m Trapezoidal rule $V = d[\frac{A_1+A_n}{2} + A_2+A_3+\dots+A_{n-1}]$ $V = 14.13\ m^3$ - 3m 3m	8m

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Bapuji Educational Association ®
Bapuji Institute of Engineering and Technology, Davangere–577 004
Department of Civil Engineering

USN										

Course/Subject Title	Basic Surveying	Course/Subject Code	18CV35
Semester	III B	Scheme	CBCS – 18
Date	23/02/2021	CIE No.	IA -III
Time	9:00-10:00 AM	Max. Marks	30

Course Outcome Statements : After the successful completion of the course, the students will be able to	
18CV35.1	Explain the fundamental concepts of surveying
18CV35.2	Apply the conventional and advanced methods for measuring horizontal distance
18CV35.3	Apply the concept of latitude and departure for the adjustment of compass closed traverse
18CV35.4	Predict the topography of the ground profile using the concepts of levelling and contours
18CV35.5	Solve two and three point problems in plane table surveying
18CV35.6	Compute areas and volumes for civil engineering projects

Note: ANSWER ANY ONE FULL QUESTION FROM EACH PART.

Q. No.	Questions	Marks	RBT Level	CO
	Part -A			
1a)	Distinguish between a) True meridian and true bearing b) Magnetic meridian and magnetic bearing c) Whole circle bearing and quandrantal bearing d) Fore bearing and back bearing.	8	L2	3
1b)	The following are the bearings of a closed traverse using a prismatic compass. Compute the included angles. Is there any error in the measurement of bearings?	7	L3	3
	OR			
2a)	The following Data pertains to a closed traverse. Adjust it by Bowditch's method.	8	L2	3
2b)	Differentiate between Prismatic compass and surveyor compass.	7	L2	3
	Part -B			
3a)	Define the following terms a) Bench Mark b) Line of Collimation c) Back Sight c) Reduced Level	8	L2	4
3b)	The following readings were observed successively with a level, the instrument having been moved after third, sixth and eight reading. Enter the readings and calculate RL of points by Rise and Fall method. If first	7	L3	4

Line	AB	BC	CD	DE	EF	FA
Bearings	37°30'	92°	151°30'	221°15'	283°	330°15'

Line	Length , M	Latitude	Departure
AB	70	21.500	-65.450
BC	80	-80.755	-5.250
CD	43	-41.000	+13.550
DE	38	-14.250	+35.150
EA	115	+114.150	+22.3015

Note: ANSWER ANY ONE FULL QUESTION FROM EACH PART.

Q. No.	Questions	Marks	RBT Level	CO
	readings was taken with a staff held on BM = 432.384m. Staff Readings 2.228, 1.606, 0.988 , 2.090, 2.864, 1.262, 0.602, 1.982, 1.044 and 2.684			
	OR			
4a)	The following notes refer to reciprocal levelling taken with one level.	8	L3	4

Instrument at	Staff Reading on		Remarks
	A	B	
A	1.824	2.748	Distance AB= 1010m
B	0.928	1.606	RL of A = 126.386m

4b)	Explain the effect of Curvature and refraction in levelling	7	L3	4

RBT (Revised Bloom's Taxonomy) Levels		
L1 : Remembering	L2 : Understanding	L3 : Applying
L4 : Analysing	L5 : Evaluating	L6 : Creating

25/02/2024

Course Coordinator
(RAGHU M E)
ASSISTANT PROFESSOR
Civil Engineering Department
B.I.E.T., Davanagere.

Coordinator
DQAC

Program Coordinator
(HOD, Civil)

Bapuji Educational Association ®
Bapuji Institute of Engineering and Technology, Davangere–577 004
Department of Civil Engineering

Scheme of Valuation

Course/Subject Title	Basic Surveying	Course/Subject Code	18CV35
Semester	IIIrd B	CIE No.	03
Date	23.02.2021	Max. Marks	30

Note: Answer any one full question from each part.

1 (a) (a) True meridian - The line passing through the geographical North pole, south pole and any point on the earth's surface is known as "True meridian" 01

True Bearing: The angle b/w true meridian and a line is known as True Bearing. 01

(b) Magnetic Meridian: When a magnetic needle is suspended freely and balanced properly unaffected by magnetic substances, it indicates "North-south direction", which is known as magnetic meridian. 01

Magnetic bearing: The angle b/w magnetic meridian and a line is called magnetic bearing 01

(c) Whole circle bearing: The magnetic bearing of a line is measured clockwise from the North towards the line. Such a bearing may have any value b/w 0 to 360° 01

It is measured by the instrument known as Prismatic compass

Reduced bearing (or) Quadrantal bearing: The magnetic bearing of a line is measured from clockwise or anticlockwise from North or South. Which ever is nearer the line towards east or west 01

(d) Fore bearing: The bearing of a line measured in the direction of progress of survey 01

Back bearing: In the opposite direction to the progress of survey 01

05 M

(b) Angle $\hat{B} = 125°30'$ $\hat{F} = 132°45'$ Fig: 1

$\hat{C} = 120°30'$ $\hat{A} = 112°45'$ calculation: 6 M

$\hat{D} = 110°15'$

$\hat{E} = 118°15'$

7 M

Course Coordinator (Faculty in charge)	Coordinator DQAC	Program Coordinator (HOD, Civil)

Bapuji Educational Association ®
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Department of Civil Engineering

Scheme of Valuation

2a) (or)

Line	length	Latitude	Departure	Correction to Latitude	Correction to Departure	Corrected Lat	Corrected Dept
AB	70	+21.500	−65.450	+0.072	−0.064	+21.572	−65.514
BC	80	−80.755	−5.250	+0.082	−0.073	−80.673	−5.323
CD	43	−41.00	+13.550	+0.044	−0.035	−40.956	+13.116
DE	38	−14.250	+35.150	+0.039	−0.034	−14.211	+35.116
EA	115	+114.150	+22.315	+0.118	−0.105	+114.268	+22.40
ΣL = 346		−0.355	+0.315	+0.355	−0.315	0	0

— 8m

2b) Difference b/w Prismatic compass and surveyor compass

7 - difference 1×7 = 7m

Part B

3a) Each Definition carries 2m × 4 = 8m — 8m

3b)

Station	BS	IS	FS	Rise	Fall	RL	Remarks
1	2.228			0		432.384	
2		1.606		0.622		433.006	
3	2.090		0.988	0.618		433.624	
4		2.864			0.774	432.850	
5	0.602		1.262	1.602		434.452	
6	1.044		1.982		1.380	433.072	
7			2.684		1.640	431.432	

$\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall$ = Last RL − First RL

0.952 = 0.952 = 0.952

4a) True Difference $h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2} = -0.801$ m

RL of B = RL of A + h = 126.386 + (−0.801) = 125.585 m

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Scheme of Valuation

Course/Subject Title		Course/Subject Code	
Semester		CIE No.	
Date		Max. Marks	

$CCR = 0.0673D^2 = 0.0673 \times \left(\frac{1010}{1000}\right)^2 = 0.069\,m$

error in collimation

$e = e_L + e_{CR}$

$e = -\left\{\frac{(a_1-b_1)-(a_2-b_2)}{2}\right\}$

$e = +0.123$

$0.123 + e_L + 0.069$

$e_L = +0.054\,m$ Since +ve line of sight is Inclined upwards.

Angular error $= \alpha = \tan^{-1}\left\{\frac{e_L}{D}\right\}$

$\tan^{-1}\left\{\frac{0.054}{1010}\right\} = 11''$

(4) curvature correction.

h's - m

$CC = 0.0785D^2$

Refraction correction $CR = 0.0112D^2$

Combined curvature & Refraction (CCR)

$CCR = 0.0785D^2 - 0.0112D^2$

$CCR = 0.0673D^2$

Course Coordinator
(Faculty-in-charge)

Coordinator
DQAC

Program Coordinator
(HOD, Civil)

CBCS SCHEME

USN | 4 | BD | 20 | CV | 4 | 10 | | | | 18CV35

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Basic Surveying

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Define surveying. Discuss the classification of surveying. **(10 Marks)**

b. What is ranging? Explain the indirect method for ranging with neat sketch. **(08 Marks)**

c. What is well conditioned triangle? **(02 Marks)**

OR

2 a. Write short notes on optical square and prism square. **(06 Marks)**

b. A big pond obstructs the chain line such that P and T are on the opposite sides of a pond and line PQ and PR were selected on the left hand side and Right hand side respectively. So that point Q, T and R were in straight line. Find length PT. Take PQ 150m, PR = 230m, QT = 75m, RT = 100m. **(08 Marks)**

c. Explain briefly chains on slopping ground by stepping method. **(06 Marks)**

Module-2

3 a. Differentiate between :
i) True meridian and magnetic meridian ii) Dip and declination iii) Agonic and isogonic lines. **(06 Marks)**

b. The following bearings were observed with compass. Calculate the interior angles and draw rough diagram.

Line	AB	BC	CD	DE	EA
Bearing	60°30′	122°0′	46°0′	205°30′	300°

(08 Marks)

c. What is local attraction? How it is detected and eliminated? Also give the reason for it. **(06 Marks)**

OR

4 a. What is traversing? What are the different types of traversing? **(04 Marks)**

b. What is closing error? Explain the Bowditch rule of graphical adjustment with sketch. **(08 Marks)**

c. Following are the observed length and bearings of the lines of a closed traverse ABCDEA. The length and bearing of line EA emitted, calculate it.

Line	Length (m)	Bearings
AB	204	87°30′
BC	226	20°20′
CD	187	280°0′
DE	192	210°30′
EA	?	?

(08 Marks)

Module-3

5 a. Explain the following terms. i) Elevation ii) Benchmark iii) Datum iv) Mean sea level. **(04 Marks)**

b. What do you understand by balancing of sight? With figure explain how the errors are eliminated. **(06 Marks)**

c. The following is the page of a level book. Find out the missing reading(X) and complete the level book. Apply usual arithmetical check.

Sl.No.	BS	IS	FS	HI	RL	Remark
1	4.000			X	X	
2		X			195.935	
3	2.150		3.995	X	X	
4		2.415			195.240	BM
5		1.665			X	
6		X			200.770	
7	3.610		X	X	X	
8			1.715		196.985	

(10 Marks)

OR

6 a. Write short notes on : i) Curvature and Refraction error ii) Borometric leveling and fly leveling iii) Collimation error and hypsometry. **(06 Marks)**

b. Describe the procedure for reciprocal leveling with neat sketch. **(06 Marks)**

c. The following observations were taken in reciprocal leveling. Determine the R.L of B if that of A is 100.150m. Also calculate the collimation error if AB = 1000m.

Inst. Station	Staff reading	
	A	B
A	1.625	2.545
B	0.725	1.405

(08 Marks)

Module-4

7 a. Describe briefly radiation method and intersection method of plane tabling. **(10 Marks)**

b. Define two point problem. Explain the graphical method of solution of two point problem with figure. **(10 Marks)**

OR

8 a. Write short notes on :i) Orientation of plane table ii) Triangle of error iii) Alidade. **(06 Marks)**

b. Discuss the temporary adjustments of plane table. **(06 Marks)**

c. What are the advantages and disadvantages of plane table? **(08 Marks)**

Module-5

9 a. What is contour? What are the uses of contour lines? **(08 Marks)**

b. A road embankment is 11m wide at the formation level and has side slope 1 : 2(V : H). The ground level at every 80m along centre line are shown in table. The formation level at zero chainage is 123.0 and embankment having a rising gradient 1 : 100 calculate the volume of earthwork by trapezoidal and primordial rule.

Dist.	0	80	160	240	320
RL	120.8	122.5	123.4	123.8	124.5

(12 Marks)

OR

10 a. Define the following terms : i) Contour interval ii) Interpolation of contour iii) Horizontal equivalent v) Contour gradient. **(04 Marks)**

b. What is planimeter? Explain the polar planimeter along with essential parts. **(12 Marks)**

c. Determine the area of plan from following data. Needle point out side plan. Zero of dial passed index mark once in clockwise direction : Initial reading = 8.364
Final reading = 4.234. **(04 Marks)**

CBCS SCHEME

USN | 4 | B | D | 0 | 0 | C | V | A | 0 | 3 | 18CV35

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Basic Surveying

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

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Module-2

3 a. Differentiate between :
i) True meridian and magnetic meridian ii) Dip and declination iii) Agonic and isogonic lines. **(06 Marks)**

b. The following bearings were observed with compass. Calculate the interior angles and draw rough diagram.

Line	AB	BC	CD	DE	EA
Bearing	60°30′	122°0′	46°0′	205°30′	300°

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4		2.415			195.240	BM
5		1.665			X	
6		X			200.770	
7	3.610		X	X	X	
8			1.715		196.985	

(10 Marks)

OR

6 a Write short notes on : i) Curvature and Refraction error ii) Borometric leveling and fly leveling iii) Collimation error and hypsometry. **(06 Marks)**

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7 a. Describe briefly radiation method and intersection method of plane tabling. **(10 Marks)**

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OR

8 a. Write short notes on :i) Orientation of plane table ii) Triangle of error iii) Alidade. **(06 Marks)**

b. Discuss the temporary adjustments of plane table. **(06 Marks)**

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b. A road embankment is 11m wide at the formation level and has side slope 1 : 2(V : H). The ground level at every 80m along centre line are shown in table. The formation level at zero chainage is 123.0 and embankment having a rising gradient 1 : 100 calculate the volume of earthwork by trapezoidal and primordial rule.

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RL	120.8	122.5	123.4	123.8	124.5

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OR

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b. What is planimeter? Explain the polar planimeter along with essential parts. **(12 Marks)**

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(18)

CBCS SCHEME

USN | 4 | B | 0 | 1 | 9 | C | V | 0 | 0 | 6 | 18CV35

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Basic Surveying

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

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(10 Marks)

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(08 Marks)

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(12 Marks)

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c. Determine the area of plan from following data. Needle point out side plan. Zero of dial passed index mark once in clockwise direction : Initial reading = 8.364
Final reading = 4.234. **(04 Marks)**

Modified

CBCS SCHEME

USN | | | | | | | | | | |

18CV35

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Basic Surveying

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define and explain plane and Geodetic surveying. **(08 Marks)**

b. Name and Explain important sources of Errors in surveying. **(06 Marks)**

c. Explain the terms Plans and Maps. Mention their application. **(06 Marks)**

OR

2 a. A field tape, standardized at 20°C measured 100.0056m. Determine the temperature at which it will be exactly of the nominal length of 100m. Take $\alpha = 11.2 \times 10^{-6}$ per °C. **(06 Marks)**

b. Name and explain the various instruments for chaining in surveying. **(14 Marks)**

Module-2

3 a. Distinguish between prismatic and surveyor's compass. **(08 Marks)**

b. Name and briefly explain temporary adjustments for prismatic compass. **(06 Marks)**

c. Define local attraction and explain the Elimation of local attraction in compass surveying. **(06 Marks)**

OR

4 a. Explain with sketches an open traverse and closed traverse. **(06 Marks)**

b. Determine the correct magnetic bearings of the liner. The following bearings were observed in running a closed traverse:

Line	F.B	B.B
AB	71° 05′	250° 20′
BC	110° 20′	292°35′
CD	161° 35′	341° 45′
DE	220° 50′	40° 05′
EA	300° 50′	121° 10′

(14 Marks)

Module-3

5 a. Define leveling and explain it. **(04 Marks)**

b. Describe with neat sketch parts of dumpy level. **(16 Marks)**

OR

6 a. Explain the terms mentioning their purpose:

i) Station
ii) Back sight
iii) Turning point
iv) Height of Instruments. **(08 Marks)**

b. A level is set up on an extended line BA in a position 70m from A and 100m from B, reads 1.684m on a staff held at A and 2.122m on a staff held at B, the bubble having been carefully brought to the centre of its run before each reading. It is known that the reduced levels of the tops of the pegs at A and B are 89.62m and 89.222m respectively. Find:
   i) The Collimation error.
   ii) The Reading that would have been obtained has there been no Collimation error. **(12 Marks)**

Module-4

7 a. Explain the working operations of plane table. **(06 Marks)**
   b. Explain Radiation and Traversing methods of plane table surveying with sketches. **(08 Marks)**
   c. Describe with sketches two-point problem in plane table surveying. **(06 Marks)**

OR

8 a. Explain briefly Intersection and Resection Methods of plane table surveying with sketches. **(10 Marks)**
   b. Describe the different Errors in plane table surveying. **(10 Marks)**

Module-5

9 a. What are the General methods of determining Areas? **(04 Marks)**
   b. A series of offsets were taken from a Chain line to a curved boundary line at Intervals of 15 meters in the following order 0, 2.65, 3.8, 3.75, 4.65, 3.6, 4.95, 5.85m. Computer the area between the chain line, the curved boundary and the end offsets by
      i) Average ordinate rule
      ii) Trapezoidal rule
      iii) Simpson's rule. **(16 Marks)**

OR

10 a. Explain with sketch planimeter. **(07 Marks)**
   b. What are the methods of locating Contours in Surveying? **(08 Marks)**
   c. Explain the calculation of the volume of the capacity of a reservoir with any one relationship. **(05 Marks)**

* * * * *

Modified

CBCS SCHEME

USN | | | | | | | | | | |

18CV35

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Basic Surveying

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

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b. Name and briefly explain temporary adjustments for prismatic compass. **(06 Marks)**

c. Define local attraction and explain the Elimation of local attraction in compass surveying. **(06 Marks)**

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(14 Marks)

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6 a. Explain the terms mentioning their purpose:

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   i) The Collimation error.
   ii) The Reading that would have been obtained has there been no Collimation error. **(12 Marks)**

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7 a. Explain the working operations of plane table. **(06 Marks)**
   b. Explain Radiation and Traversing methods of plane table surveying with sketches. **(08 Marks)**
   c. Describe with sketches two-point problem in plane table surveying. **(06 Marks)**

OR

8 a. Explain briefly Intersection and Resection Methods of plane table surveying with sketches. **(10 Marks)**
   b. Describe the different Errors in plane table surveying. **(10 Marks)**

Module-5

9 a. What are the General methods of determining Areas? **(04 Marks)**
   b. A series of offsets were taken from a Chain line to a curved boundary line at Intervals of 15 meters in the following order 0, 2.65, 3.8, 3.75, 4.65, 3.6, 4.95, 5.85m. Computer the area between the chain line, the curved boundary and the end offsets by
      i) Average ordinate rule
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10 a. Explain with sketch planimeter. **(07 Marks)**
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* * * * *

RNS INSTITUTE OF TECHNOLOGY

(AICTE Approved, VTU Affiliated and NAAC 'A' Accredited)
(UG programs - CSE, ECE, ISE, EIE and EEE have been Accredited by NBA
for the Academic Years 2018-19, 2019-20 and 2020-21)
Channasandra, Dr. Vishnuvardhan Road, Bengaluru - 560 098

DEPARTMENT OF CIVIL ENGINEERING

Dated:09-01-2020

From,
Chairman
BoE-CV/TR/EV 2019
VTU, Belagavi

It is hereby informed that the Question Paper, Scheme and Solutions in the following subjects are found to be in order with a note on minor incorporations

Sl No	Subject Code	Name of the Subject	Remarks
1	17CV561	Traffic Engineering	Question paper and Scheme is Found correct with a following note.: *All the answers shall be evaluated as per revised marks distribution shown in the scheme- totaling maximum of 20 marks per each module questions*
2	17CV_CT563	Remote Sensing and GIS	Question paper and Scheme Found Correct
3	18CV35	Basic Surveying	Question Paper and Scheme Found Correct with a following note: *All the answers shall be evaluated as per revised marks distribution shown in the scheme- totaling maximum of 20 marks per each module questions*

Thanking you

Dr. M T PRATHAP KUMAR
CHAIRMAN-2019-20
BOE-CV/CT/EV/(COMPOSITE)BOARD
Visvesvaraya Technological University,
Belagavi-590 018.
Phone: 9741440958/9448687042

APPROVED
9/1/2020
Registrar (Evaluation)
Visvesvaraya Technological University
BELAGAVI-18

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Channasandra, Dr. Vishnuvardhan Road, Bengaluru - 560 098

DEPARTMENT OF CIVIL ENGINEERING

Dated:09-01-2020

From,
Chairman
BoE-CV/TR/EV 2019
VTU, Belagavi

It is hereby informed that the Question Paper, Scheme and Solutions in the following subjects are found to be in order with a note on minor incorporations

Sl No	Subject Code	Name of the Subject	Remarks
1	17CV561	Traffic Engineering	Question paper and Scheme is Found correct with a following note.: *All the answers shall be evaluated as per revised marks distribution shown in the scheme- totaling maximum of 20 marks per each module questions*
2	17CV_CT563	Remote Sensing and GIS	Question paper and Scheme Found Correct
3	18CV35	Basic Surveying	Question Paper and Scheme Found Correct with a following note: *All the answers shall be evaluated as per revised marks distribution shown in the scheme- totaling maximum of 20 marks per each module questions*

Thanking you

Dr. M T PRATHAP KUMAR
CHAIRMAN-2019:20
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BELAGAVI - 18

Visvesvaraya Technological University
Belagavi, Karnataka - 590 018

Scheme & Solution

C.P. Nagaraj
Signature of Scrutinizer

Subject Title : Basic Surveying Subject Code : 18CV35

Question Number	Solution	Marks Allocated
1.	module-1 a. Defination of plane Surveying - (2) (1) Explanation (2) (3) Defination of Geodetic Surveying - (2) (1) Explanation - (2) (3)	8
	b. a) Instrumental - b) Personal - c) Natural - } Explanation 2 marks each	6
	c. Plank Explaination (3) (2) maps Explaination (3) (2) Application - (1) (1) OR	6
2.	a. Given $\delta l = 0.0056$ m $T_0 = 20^\circ$C. Std temp $T_0^\circ = T_0 \pm \frac{\delta l}{l d} \rightarrow$ (2) $= 20 - \frac{0.0056}{100 \times 11.2 \times 10^{-6}}$ $= 20^\circ - 5^\circ = 15^\circ$C (4)	6
	b. 1. Chain or tape 2. Arrows 3. pegs 4. Ranging rods (5) offset rods (6) Plastered lime and whites (7) plumb bob explain (2)	14

(2)

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Subject Title : Subject Code :

Question Number	Solution	Marks Allocated
	module-2	
3.	a. Any 6 differences × 1½ marks each	8
	b. Centring levelling Focusing the prism } × 2 mars	6
	c. Definition of local attraction – (2) First method → (2) Second method → (2) (OR)	6
4.	a. errors may be classified as open traverse – (3) closed traverse – (3) (1) Instrumental (2) personal (3) natural × 2 marks	6
	b. By Inspection CD differ +10' (2) Corrected F.B of CD = 161° 40' (2) Corrected B.B of CD = 341° 40' (2) Sum = 543° 15' Diff 180° 0' (2) ∠ABC = 139° 45' ∠BCD = 130° 45' ∠CDE = 120° 40' (8) ∠DEA = 99° 00' ∠EAB = 49° 50' 540° 00' Sum check – (4) Correction for Y Each angle = -15' (2) Tabular Column showing corrected bearings of each line → (08)	14

Subject Title : Subject Code :

Question Number	Solution	Marks Allocated
5	**module - 3** a) Defination — (2) Explain — (2)	4
	b) Describe with neat Sketch of dumpler Sketch — (6) marks Parts → (10) marks. OR	16
6	a. Station Back Sight Tuning point Height of Instrument } 4 × 2 purpose & Explaination	8
	b Exact diff in elevation in B & A = 89.62 − 89.222 = 0.398 m (2) As per obervations, difference in elevation = 2.122 − 1.684 = 0.438 m (2) α = 4'34" upwards (1) Exact reading no collimation error At A = 1.591 m (1) At B = 1.989 m (1) So that the true difference in elevation = 1.989 − 1.591 = 0.398 m (2)	12

Subject Title : Subject Code :

Question Number	Solution	Marks Allocated
	module - 4	
7.	a) 1) Fixing → (1) 2) Setting → (4) 3) Sighting the points → (1)	6
	b) Radiation methods with Sketch → (4) Traversing methods with Sketch → (4)	8
	c) Two-point problem with Sketch Sketch → (2) Explination → (4) } 6	6
8.	a. Intersection method with Sketch (6) Resection method with Sketch (4)	10
	b) 1) Instrumental errors → (2) 2) Errors in plotting → (2) 3) Error due to manipulation & Sighting (6)	10
	module - 5	
9.	a. By computations based directly on field measurements → (2)	4
	b. By Computation based on measured Scaled from a map → (1)	
	c. By mechanical method. - Plainmeter	

Solution	Marks Allocated

(b) a) By average ordinate rule

$$\Delta = \frac{L}{n+1}\{O\} = 383.91 \text{ m}^2$$ (5)

b) By trapezoidal rule

$$\Delta = \left[\frac{O_0+O_n}{2} + O_1 + O_2 + \cdots O_{n-1}\right]d$$

$$\Delta = 394.87 \text{ m}^2$$ (6)

c) By Simpson's rule

$$\Delta = d/3\left[(O_0+O_n) + 4(O_1+O_3+\cdots O_{n-1}) + 2(O_2+O_4+\cdots O_{n-2})\right]$$

$$\Delta = 390.25 \text{ m}^2$$ (5)

(16)

OR

10. a. Planimeter with Sketch — (4)
Explanation. — (3)

(7)

b. 1) Direct method → 4
2) Indirect method → (4)

(8)

(21)

c) Explain the calculation of the Volume of the capacity of a reservoir with any one relation ship with any one trapezoidal formula (5)

OR

prismoidal rule with strip | Sketch + formula (5)

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Module - 2

COMPASS SURVEYING

Meridians and Bearings.

A meridian is a fixed line of reference, from which the angles of lines are measured. The angle made by the line with reference to a meridian is called the "bearing" of the line. There are three types of meridians and bearings. They are

1. True meridian and true bearing
2. Magnetic meridian and magnetic bearing
3. Arbitrary meridian and arbitrary bearing.

The line passing through the geographical north pole, south pole and any point on the earth's surface is known as "true meridian", which is constant at a station. True meridians through different points on the earth's surface converge towards the poles. The angle between true meridian and a line is known as "true bearing" or "Azimuth".

When a magnetic needle is suspended freely and balanced properly, unaffected by magnetic substances, it indicates 'north-south' direction, which is known as "magnetic meridian". The angle between magnetic meridian and a line is called "magnetic bearing".

Some times, a convenient direction is selected as a meridian for the survey of a small area. This arbitrarily selected direction is known as the "arbitrary meridian". The angle between the arbitrary meridian and a line is known as "arbitrary bearing".

Designation of magnetic bearings:

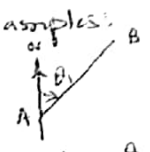
The magnetic bearings are designated by the following two systems.

1. Whole Circle Bearing (WCB) system.

and 2. Quadrantal Bearing (QB) system

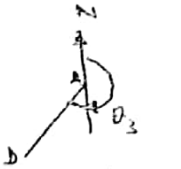
1. WCB System: In this system, the magnetic bearing of a line is "measured ~~from North~~ clockwise from the north towards the line". Such a bearing may have any value between 0° and 360°. It is measured by the instrument known as "Prismatic Compass".

Examples:

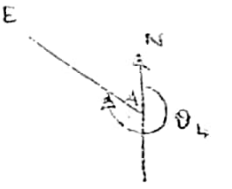


WCB of AB = θ_1

WCB of AC = θ_2



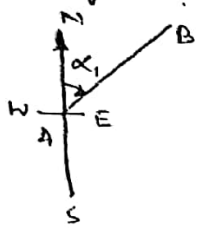
WCB of AD = θ_3



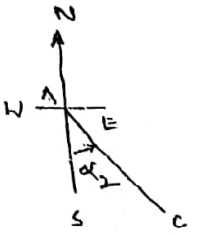
WCB of AE = θ_4

2 QB System. In this the magnetic bearing of a line is "measured clockwise or counterclockwise from North or South which ever is nearer the line towards East or West". The four quadrants adopted in this system are North-East (NE), SouthEast (SE), South-West (SW) and North-West (NW). The value of a quadrantal bearing lies between 0° and 90°, but the quadrant should always be specified. Quadrantal bearings are measured with "Surveyors Compass".

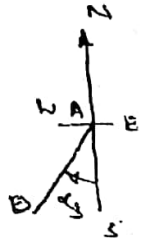
Examples:



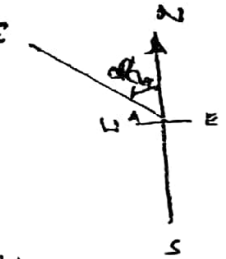
Q.B of AB = N α_1 E



Q.B of AC = S α_2 E

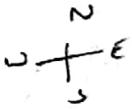


Q.B of AB = S α_3 W



QB of AF = N α_4 F

Note: 1. The following table is useful to convert QB to WCB:



QB	WCB
N α_1 E	$\theta_1 = \alpha_1$
S α_2 E	$\theta_2 = 180 - \alpha_2$
S α_3 W	$\theta_3 = 180 + \alpha_3$
N α_4 W	$\theta_4 = 360 - \alpha_4$

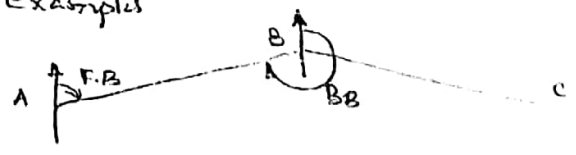
2 The above table is also helpful to convert WCB to QB.

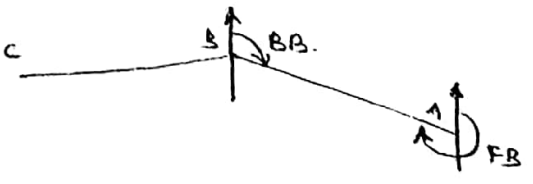
The WCB when converted to QB is also known as "Reduced Bearing" (RB)

Fore Bearing and Back Bearing:

The bearing of a line measured in the direction of progress of survey is called "Fore Bearing" (FB) of the line. When the bearing of a line is measured in the ~~direction~~ directions, opposite to the progress of survey, it is called "Back Bearing" (BB) of the line.

Examples

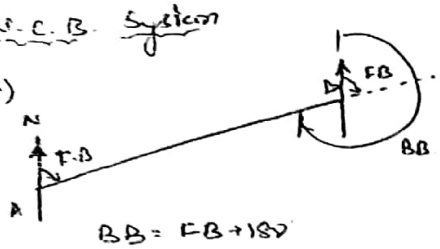




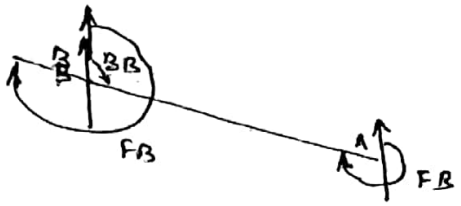
Relationship between FB and BB

1. W.C.B. System

a)



$BB = FB + 180°$

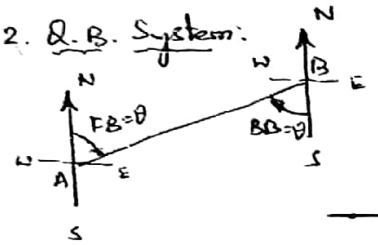


$BB = F - 180°$

$\therefore \boxed{BB = FB \pm 180°}$

Use + when $FB < 180°$ and
− when $FB > 180°$

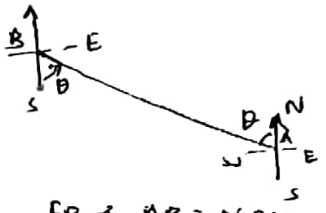
2. Q.B. System:



FB of AB = N θ E

BB of AB = S θ W

(Change to diagonally opposite Quadrant Segment)



FB of AB = N θ W

BB of AB = S θ E

(Change to diagonally opposite Segment.

Magnitude of angle is same but Quadrant changes

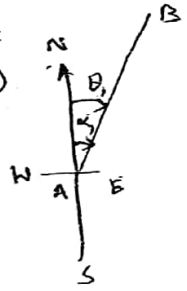
Examples:

1. Convert the following QB of lines to W.C.B.

i) AB = N26°45'E ii) BC = S43°30'E iii) CD = S36°30'W iv) DE = N40°15'W

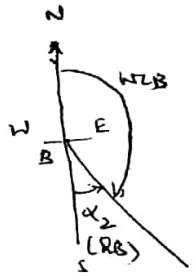
Sol^n:

i)



WCB of AB = QB of AB
= 26°45'

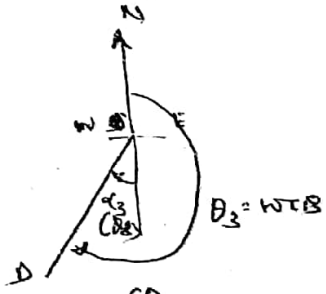
ii)



C

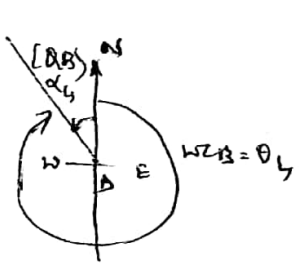
WCB of BC = 180 − α2
= 180 − 43°30'
= 136°30'

iii)



WCB of CD = 180 + α3
= 180 + 36°30'
= 216°30'

iv)

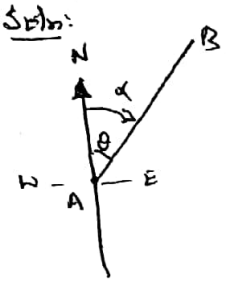


WCB of DE = 360 − α4
= 360 − 40°15'
= 319°45'

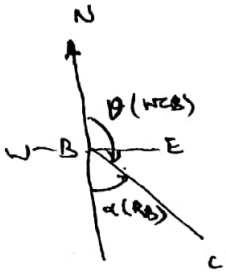
2. Convert the following NCB to RB (or RB)

i) AB = 45° 30' ii) BC = 125° 45' iii) CD = 222° 15' and iv) DE = 320° 30'

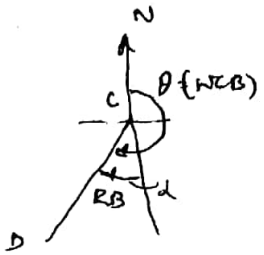
Soln:



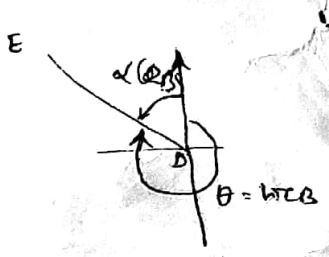
RB of AB = N θ E
= N45° 30' E



RB of BC = S(180 - θ)E
= S 54° 15' E



RB of CD = S(θ - 180)W
= S 42° 15' W



RB of DE = N(360 - θ) W
= N 39° 30' W

3. Find the back bearing of the following lines given that the fore bearing of

i) AB = 60° 45' ii) BC = 145° 15' iii) CD = 210° 30' and DE = 310° 30'

Soln: ~~BB of a line~~ = FB of that line ± 180 + when FB < 180 and
- when FB > 180°

(i) BB of AB = 60° 45' + 180 = 240° 45'
(ii) BB of BC = 145° 15' + 180° = 325° 15'
(iii) BB of CD = 210° 30' - 180° = 30° 30'
(iv) BB of DE = 310° 30' - 180° = 130° 30'

4. Find the Back Bearing of the following lines given that the fore bearing of

i) AB = N 45° 30' E ii) BC = S 30° 30' E iii) CD = S 60° 15' W iv) DE = N 40° 30' W.

Soln: In BB system, the magnitude of BB is equal to the magnitude of FB
But i) N is replaced with S and Vice Versa
ii) E is replaced with W and Vice Versa.

BB of AB = S 45° 30' W
BB of BC = N 30° 30' W
BB of CD = N 60° 15' E
BB of DE = S 40° 30' E

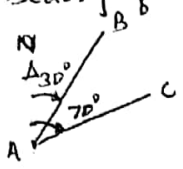
CALCULATION OF ANGLES FROM BEARINGS:

(Analysis is based on the sketches drawn with concept of definitions)

1. Compute the angles for the following cases.

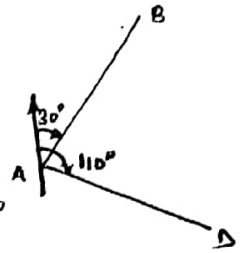
Case (i) Bearing of AB = 30°
Bearing of AC = 70°

Soln:



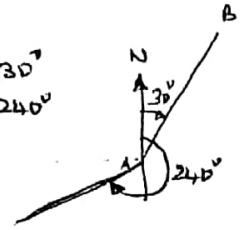
$\hat{BAC} = 70 - 30$
$= 40°$

Case (ii) AB = 30°
AD = 110°



$\hat{BAD} = 110° - 30°$
$= 80°$

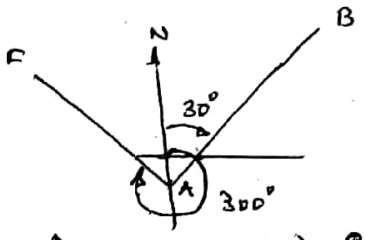
(iii) AB = 30°
AE = 240°



$\hat{BAE}$ (Extend) $= 240 - 30$
$= 210°$

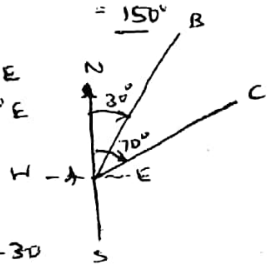
If included angle is required $BAE = 360 - 210°$
$= 150°$

(iv) AB = 30°
AF = 300°



$\hat{BAF} = 30 + (360 - 300) = 90°$

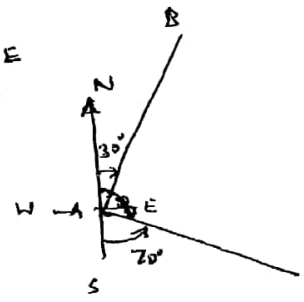
(v) AB = N 30° E
AC = N 70° E



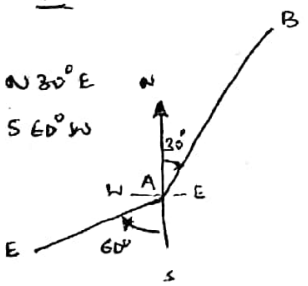
$\hat{BAC} = 70 - 30$
$= 40°$

(vi) AB = ~~30°~~ N 30° E
AD = S 70° E

$\hat{BAC} = 180 - 30 - 70$
$= 80°$



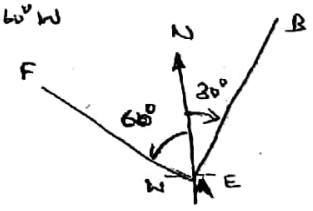
(vii) AB = N 30° E
AE = S 60° W



$\hat{BAC}$ (Ext) $= (180 - 30) + 60$
$= 210°$

$\hat{BAC}$ (Int) $= 360 - 210 = 150°$

(viii) AB = N 30° E
AF = N 60° W



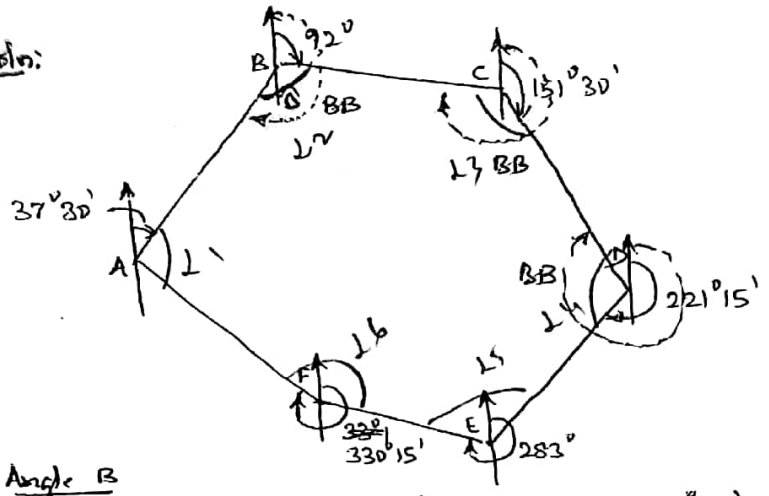
$\hat{BAF} = 30 + 60$
$= 90°$

2. The following are the bearings of a closed traverse using a prismatic compass. Compute the included angles. Is there any error in the measurement of bearings.

Line	AB	BC	CD	DE	EF	FA
Bearings	37°30'	92°	151°30'	221°15'	283°	330°15'

PTO

Soln:



Angle B

Line AB : FB = 37°30' BB = 37°30' + 180 = 217°30' (Previous line)

BC : FB = 92° (Next line)

$\therefore \hat{B}$ = BB of AB − FB of BC = 217°30' − 92° = 125°30'

Angle C

Line BC : FB = 92° BB = 92 + 180 = 272°

CD : FB = 151°30'

$\therefore \hat{C}$ = BB of BC − FB of CD = 272° − 151°30' = 120°30'

Angle D

Line CD : FB = 151°30' BB = 151°30' + 180 = 331°30'

DE : FB = 221°15'

$\therefore \hat{D}$ = 331°30' − 221°15' = 110°15'

Angle E:

Line DE : FB = 221°15' BB = 221°15' − 180 = 41°15'

EF : FB = 283°

$\hat{E}$ = 41°15' − 283° = −241°45' (Reflected)

$\therefore$ Internal angle $\hat{E}$ = −241°45' + 360 = 118°15'

Angle F

Line EF : FB = 283° BB = 283 − 180 = 103°

FA : FB = 330°15'

$\therefore \hat{F}$ = 103° − 330°15' = −227°15' (Ext)

$\therefore$ F = 360° − 227°15' + 360 = 132°45'

Angle A

Line FA : FB = 330°15' ; BB = 330°15' − 180 = 150°15'

AB : FB = 37°30'

$\therefore \hat{A}$ = 150°15' − 37°30' = 112°45'

Rule to calculate angles in clockwise traverse:

Angle = BB of Previous line − FB of following or next line

If negative add 360°

If there is no error in the observation of bearings, the sum of included angles must be equal to [(2n−4)×90] where n = no of sides.

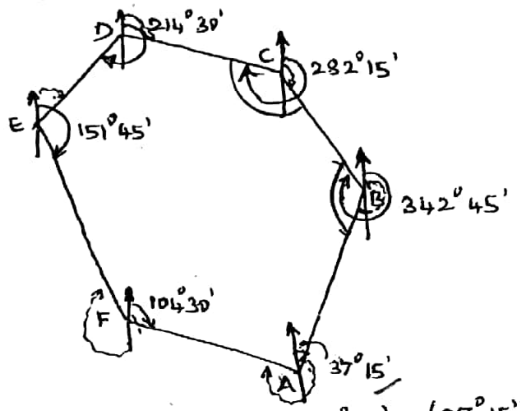
Here Sum = $\hat{A} + \hat{B} + \hat{C} + \hat{D} + \hat{E} + \hat{F}$ = 720°

(2n−4)×90 = (2×6−4)×90 = 720° $\therefore$ O.K & no error in bearing observation.

3). The following are the bearings of a closed traverse. Compute the included angles and the sum of interior angles. If there is any error, correct the interior angles assuming the error to be equal in all the angles.

Line	AB	BC	CD	DE	EF	FA
Bearings	37°15'	342°45'	282°15'	214°30'	151°45'	104°30'

Soln:



$\hat{B}$ = FB of BC − BB of AB = 342°45' − (37°15' + 180°) = 125°30'

$\hat{C}$ = FB of CD − BB of BC = 282°15' − (342°45' − 180) = 119°30'

$\hat{D}$ = FB of DE − BB of CD = 214°30' − (282°15' − 180) = 112°15'

$\hat{E}$ = FB of EF − BB of DE = 151°45' − (214°30' − 180°) = 117°15'

$\hat{F}$ = FB of FA − BB of EF = 104°30' − (151°45' + 180) =

= −227°15' (ext)

= −227°15' + 360°

= 132°45'

$\hat{A}$ = FB of AB − BB of FA = 37°15' − (104°30' + 180)

= −247°15' (ext)

= −247°15' + 360

= 112°45'

Sum of all the interior angles = $\hat{A} + \hat{B} + \hat{C} + \hat{D} + \hat{E} + \hat{F}$

= 720°

$(2n-4) \times 90 = (2 \times 6 - 4) \times 90$ = 720° ∴ ok (No error)

Rule for Calculating angles in counterclockwise traverse

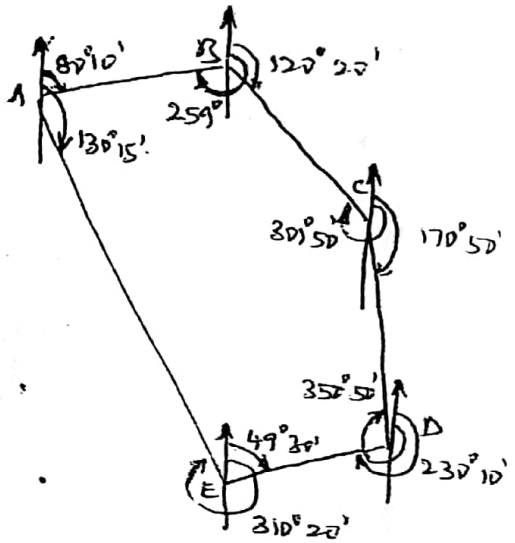
Angle = F.B of next line − B.B of previous line

If negative add 360°

4) The following are the bearings taken in a closed traverse. Compute the interior angles. Find the sum of the interior angles and correct for observational errors assuming the error to be equal in all the angles.

Line	FB	BB
AB	80°10'	259°00'
BC	120°20'	301°50'
CD	170°50'	350°50'
DE	230°10'	49°30'
EA	310°20'	130°15'

Soln:



FBAB = 80°10'

BA ?

~~120°20' + 215° (for)~~

$\hat{B} = 259°00' - 120°20' = 138°40'$

$\hat{C} = 301°50' - 170°50' = 131°00'$

$\hat{D} = 350°50' - 230°10' = 120°40'$

$\hat{E} = (49°30' - 310°20') + 360° = 99°10'$

$\hat{A} = 130°15' - 80°10' = 50°05'$

Sum = 539°35'

For pentagon the sum should be $(2\times5-6)\times90 = 540°$

∴ Error = Observed Value − Actual Value

= 539°35' − 540°00'

= −25'

∴ Correction = +25'

This is divided equally among all the FIVE angles.

∴ Correction per angle = $+\left(\frac{25}{5}\right) = +5'$

∴ Corrected angles are

$\hat{B} = 138°40' + 5 = 138°45'$

$\hat{C} = 131°00' + 5 = 131°05'$

$\hat{D} = 120°40' + 5 = 120°45'$

$\hat{E} = 99°10' + 5 = 99°15'$

$\hat{A} = 50°05' + 5 = 50°10'$

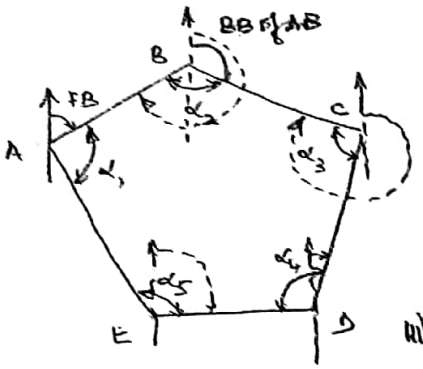
$\Sigma = 540°$ ∴ ok.

Computation of bearings of lines of a closed traverse, given the bearing of one of the lines

Case 1 Clockwise traverse:

Given: FB of AB

Angles $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ and α_5



Reqd: F.B of i) BC
ii) CD
iii) DE
iv) EA

BB = FB ± 180°

FB of BC = BB of AB − α_2

iii) FB of CD = BB of BC − α_3

FB of DE = BB of CD − α_4

= −ve Hence Add 360°

FB of EA = BB of DE − α_5

= −ve Hence add 360°

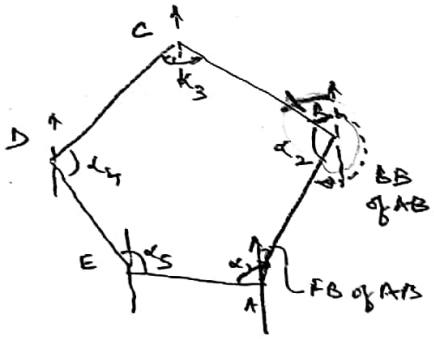
Check: FB of AB = BB of EA − α_1

∴ Rule: F.B of next line = B.B of previous line − Included angle
If −ve, add 360°

Case 2. Counter clockwise traverse:

Given: FB of AB

Angles $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ and α_5



Reqd: FB of i) BC
ii) CD
iii) DE
iv) EA

FB of BC = BB of AB + α_2

iii) FB of CD = BB of BC + α_3

FB of DE = BB of CD + α_4

FB of EA = BB of DE + α_5 > 360° ∴ Subtract 360°

Check: FB of AB = BB of EA + α_1 > 360° ∴ Subtract 360°

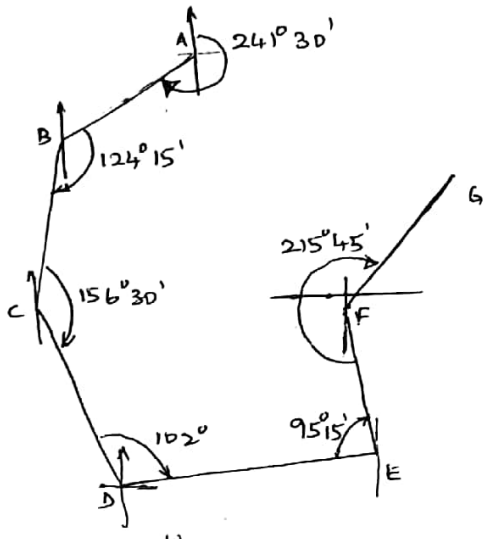
Rule: FB of next line = BB of Previous line + Included angle
If more than 360°, Subtract 360°

Ex.1 : The following angles were observed in the anti clockwise direction in an open traverse.

$\angle ABC = 124^\circ 15'$; $\angle BCD = 156^\circ 30'$; $\angle CDE = 102^\circ$; $\angle DEF = 95^\circ 15'$; $\angle EFG = 215^\circ 45'$

The magnetic bearing of the line AB was $241^\circ 30'$. Find the bearing of the other lines.

Soln:



Soln: Traverse is anti clockwise

∴ FB of next line = BB of Previous line + Angle If more than 360° Subtract 360°

FB of BC = (241° 30' − 180°) + 124° 15' = 185° 45'

FB of CD = BB of BC + Angle
= (185° 45' − 180°) + 156° 30' = 162° 15'

FB of DE = BB of CD + Angle
= [(162° 15' + 180°) + 102°] − 360° = 84° 15'

FB of EF = BB of DE + Angle
= (84° 15' + 180°) + 95° 15' = 359° 30'

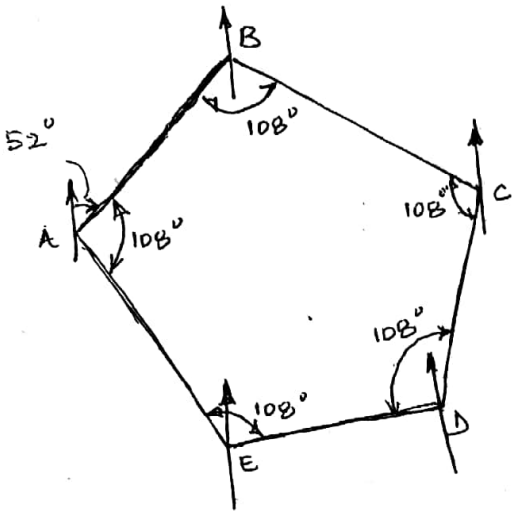
FB of FG = BB of EF + Angle
= [(359° 30' − 180°) + 215° 45'] − 360° = 35° 15'

Ex:2 : Find the bearings of the lines of a regular pentagon in clockwise direction, if the bearing of the first line is 52°.

Soln: Let ABCDE be the pentagon in clockwise direction (Ref. fig)

The interior angle of pentagon is

$= \frac{(2n-4)\times 90}{n} = \frac{(2\times 5-4)\times 90}{5} = 108^\circ$



FB of BC = BB of AB − Angle

$= (52° + 180°) - 108°$ $= 124°$

FB of CD = BB of BC − Angle

$= (124° + 180°) - 108°$ $= 196°$

FB of DE = BB of CD − Angle

$= [(196° - 180°) - 108°] + 360$ $= 268°$

FB of EA = BB of DE − Angle

$= [(268 - 180) - 108] + 360°$ $= 340°$

Check: FB of AB = BB of EA − Angle

$= (340° - 180°) - 108°$ $= 52°$ ∴ Ok

3) Compute the bearings of a regular hexagon ABCDEF in anticlockwise direction, given the bearing of AB = 50°.

Soln: Interior angle $= \frac{(2n-4)\times 90}{n} = \frac{(2\times 6-4)\times 90}{6} = 120°$

Bearing of BC = $(50 + 180) + 120° = 350°$

Bearing of CD = $(350 - 180) + 120 = 290°$

Bearing of DE = $(290 - 180) + 120 = 230°$

Bearing of EF = $(230 - 180) + 120 = 170°$

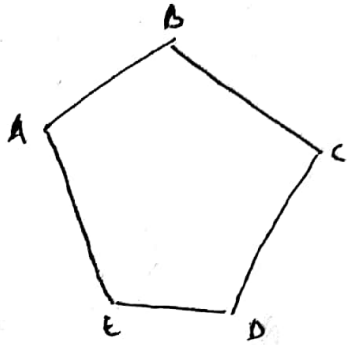
Bearing of FA = $[(170 + 180) + 120°] - 360° = 110°$

Check: Bearing of AB = $[(110° + 180°) + 120] - 360° = 50°$ ∴ Ok

TRAVERSE:

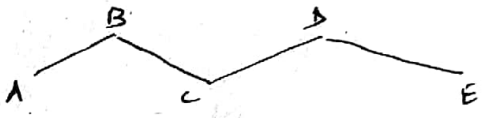
Traverse means, determining the lengths and direction of consecutive lines. In compass traverse, traverse, the linear measurements are made with a chain or tape and the directions are made with a compass. There are two types of traverses. They are 1) Closed traverse and 2) Open traverse.

1) Closed traverse: A traverse, when returned to the starting point is known as 'closed traverse'. This is commonly used for locating boundary of an area or determining the area of the boundary, or mapping of an area etc.



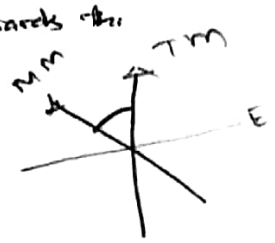
A closed traverse can be checked and adjusted.

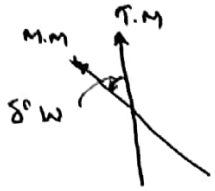
2) Open traverse: When a traverse does not return to its starting point, it is known as "open traverse". This type is used for surveying long narrow strips like the paths of highway, railway etc.



An open traverse cannot be checked.

Magnetic Declination: "Magnetic declination is the horizontal angle between the true meridian and the magnetic meridian." If magnetic meridian is towards the East of true meridian, it is "Eastern declination" and if towards the West of true meridian, it is "Western declination".





TM: True Meridian ; MM: Magnetic Meridian

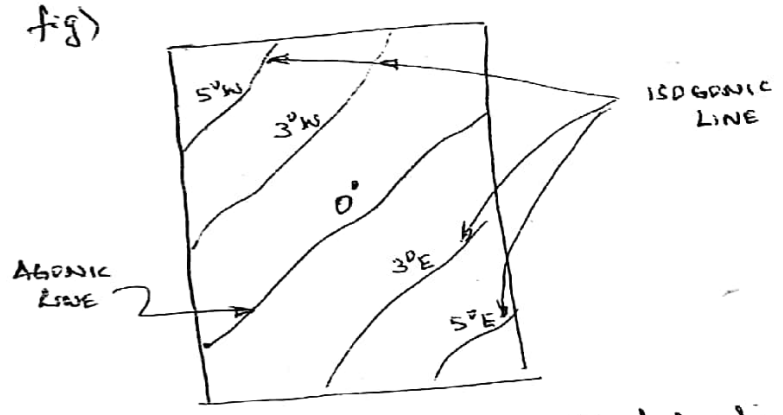
δ = declination, E = East ; W = West.

The magnetic declination at a place is not constant. It varies due to

i) rotation of earth along its elliptical path (1' - 2') ——————

ii) rotation of earth about its own axis (3'-12')

The survey department of India has prepared a map showing "ISOGONIC" lines and "AGONIC" Lines. Isogonic line is the line passing through points of equal declination. Agonic line is an isogonic line corresponding to Zero declination. (Ref fig)

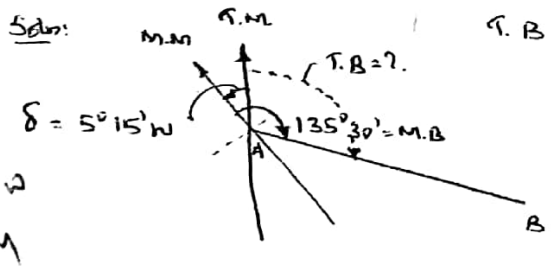


Examples on magnetic declination:

(Draw the sketch and analyse)

1) The magnetic bearing of a line AB is 135° 30'. What will be its true bearing if the declination is 5° 15' W.

Soln:



T. B = MB − δ = 135° 30' − 5° 15' = 130° 15' Ans.

MB = 135° 30'

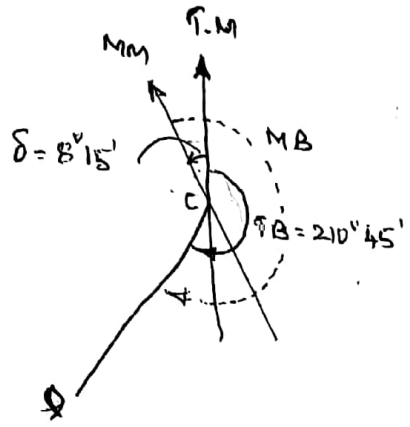
δ = 5° 15' W

T. B = MB − δ

TB = 135° 30' − 5° 15

2) The true bearing of a line CD is 210° 45'. What will be the magnetic bearing if the declination is 8° 15' W

Soln:

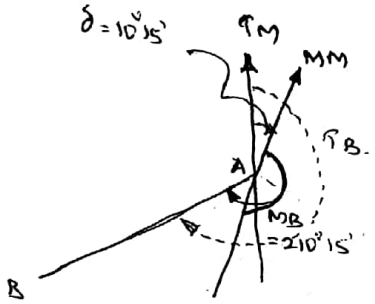


$MB = TB + \delta = 210°45' + 8°15'$

$= 219°$

3) The magnetic bearing of a line AB is S 30° 15' W. Find its true bearing if the declination is 10° 15' E.

Soln: WCB of AB = 180 + 30° 15' = 210° 15'

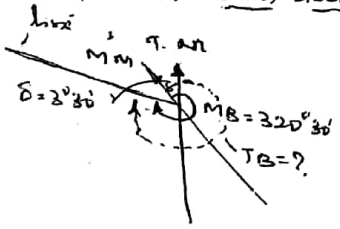


$TB = MB + \delta = 210°15' \to 10°15' = 220°30'$

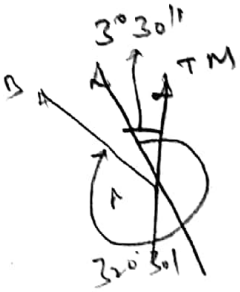
∴ T.B of AB in Q.B. System = S 40°30' W

4) On an old map, a line WAB drawn to a magnetic bearing of 320° 30', when the declination was 3° 30' W. Find the present bearing of the line, if the declination is 4° 15' E.

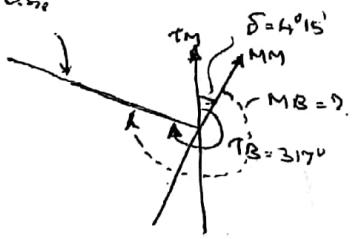
Soln: (i) When declination was 3° 30' W



$TB = MB - \delta = 320°30' - 3°30' = 317°$



(ii) When declination is 4° 15' E



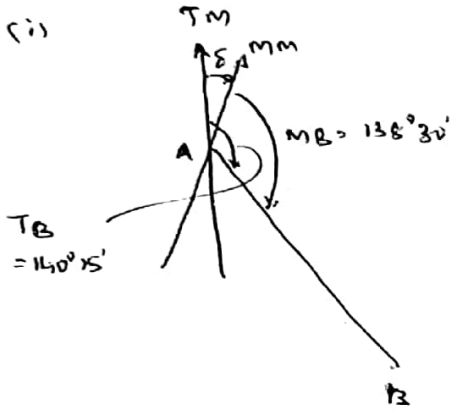
$MB = TB + \delta = 317° - 4°15'$

$= 312°45'$

1) Find the declination for the following two cases.

Case	Line	True Bearing	Magnetic Bearing	
(i)	AB	140° 15'	138° 30'	δ = TB − MB
(ii)	CD	230° 15'	232° 15'	If + E If − W

Soln: (i)



δ° E = (TB − MB) E

= (140°15' − 138°30') E

= 1°45' E.

ii)

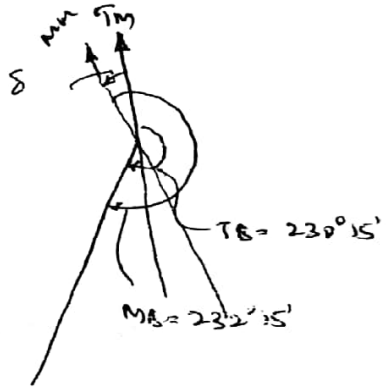
δ = TB − MB

= 230°15' − 232°15'

= −2° (−ve)

∴ Declination is West ward.

∴ δ = 2° W



Dip of the magnetic Needle:

If a needle is perfectly balanced before magnetization, it does not remain horizontal after it is magnetised. This is due to magnetic influence of the earth. The needle is found to be inclined towards the pole. The inclination of the needle with the horizontal is called "Dip of the magnetic needle".

It is found that the North end of the needle is deflected downwards in the northern hemisphere. Similarly the South end of the needle is deflected downwards in the southern hemisphere. The needle is just horizontal at the equator.

To balance the dip of the needle, a "rider" (Brass or Silver coil) is provided with the needle

Prismatic Compass:

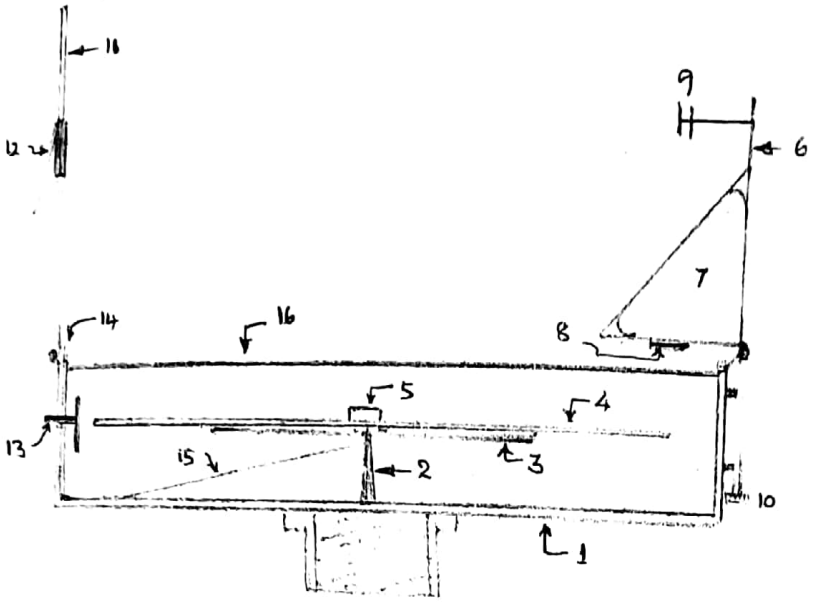


Fig. Prismatic Compass.

A prismatic compass which gives bearings in WCB system consists of the following parts. (Ref. fig)

1. A circular box of about 100 mm diameter
2. A pivot of hard steel at the centre of the box.
3. A broad magnetic needle resting balanced on this pivot
4. A Graduated ring attached to the magnetic needle.
   This is graduated to degrees and half degrees from 0° to 360°. The zero (ie 360°) is marked at the 'SOUTH' end of the needle and increasing in the clockwise direction. The numbers (indicating the angle) on the graduated ring are engraved inverted as they are viewed through the prism.
5. Agate Cap, which helps in balancing of magnetic needle.
6. Eye vane for sighting objects and taking readings. This is hinged to the circular box.
7. A prism in the eye vane. The faces of the prism are made convex to make it as magnifier. The vertical face of the prism is provided with a vertical slit
8. A prism cap to cover the prism, when not in use.
9. Sun glasses, (two numbers) to sight bright objects.
10. Focussing screw or stud to raise or lower prism so that the graduations on the ring are seen clearly
11. Object vane consisting of a frame with a vertical hair. This is hinged to the circular box and placed diametrically opposite to the eye vane. The
12. Hinged mirror hinged to a slider, which slides on the frame of the mirror is useful to bright objects which are higher or lower than the horizontal line of sight.
13. Brake pin to reduce the oscillations of the graduated ring.
14. Lifting pin and tilting lever, which lift the needle off the pivot and prevent undue wear of the pivot point.
16. Glass cover to prevent the entry of dust into the circular box.

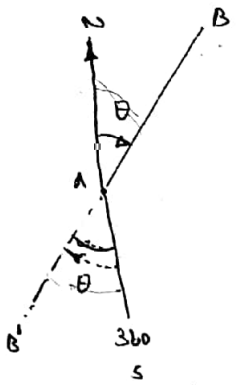
17. Tripod, which has a 'Ball and Socket' arrangement for levelling the compass.
18. A 'lid' to cover the box, when not in use.

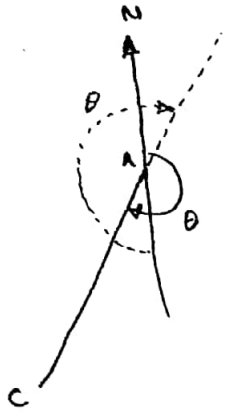
Terms: 1. Line of Sight: Line joining the Vertical slit in the prism of eye vane and the Vertical hair of object vane.

2. Centring: This is the process of keeping the compass in such a way that "the centre of compass is right above the station". This can be achieved by dropping a small piece of stone, so that it falls on the tip of the peg.

3. Levelling: This is the process of keeping the circular box or magnetic needle in horizontal plane. This can be achieved by eye judgement by means of "Ball and Socket" arrangement so the the graduated ring rotates freely.

NOTE: Since the reading is taken through the prism, which is at the "South" end of the needle, 360° (or Zero) is marked at the South end. Also the angle or bearing from South of the line from South end in clockwise is equal to the bearing of the same line from North end in clockwise direction. (Ref. fig)





Surveyor's Compass:

A Surveyor's Compass, which gives bearing of the lines in R.B. system, consists of the following parts (Refer fig)

1. A circular box of about 125 mm diameter.
2. A circular graduated ring fixed to the inside brim of the box. The ring is graduated in quadrantal bearing system with 0° at "NORTH and SOUTH" ends and 90° at "EAST and WEST" ends, the EAST and WEST ends being interchanged.
3. A pivot of hard steel at the centre of the box
4. An edge bar type of magnetic needle, balanced on the pivot with the help of an "AGATE CAP".
5. An agate cap, which balances the magnetic needle.
6. An eye vane in the form of frame with a vertical slit, attached to the box.
7. An object vane, consisting of a frame with a vertical hair. This is placed diametrically opposite to the eye vane.
8. A glass cover to prevent of entry of dust into the box.
9. Tripod.

Comparison between P.C and S.C

Item.	P.C	S.C
1. Magnetic needle.	Broad type & does not act as an index.	Edge bar type & acts also as an index.
2. Graduated ring.	* Attached to the needle. * Does not rotate with line of sight. * Graduations are in WCB Zero at South, 90° at West, 180° at North & 270°E at East. * Graduations are in Number numbers are engraved inverted.	* Attached to the box. * Rotates with the line of sight. * Graduations are in R.B. Zero at North & South, and 90° at East & West. * Graduations in numbers are engraved erect.
3. Eye Vane.	Prism with a slit.	Simple frame with slit.
4. Reading.	Taken with the help of prism.	Taken directly by looking through the top of Glass cover.
5. Tripod.	may or may not be required.	Required.

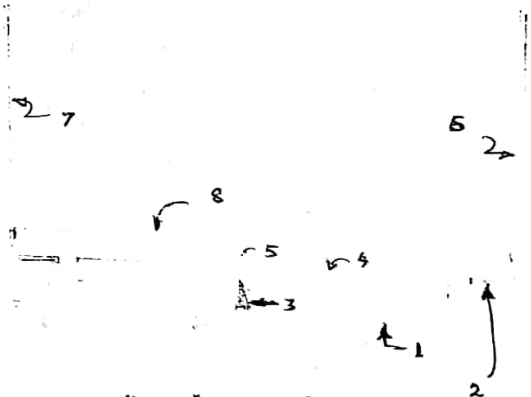


Fig. Surveyor Compass

B. E. CIVIL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – III

BASIC SURVEYING

Course Code	**18CV35**	CIE Marks	40
Teaching Hours/Week(L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students to;

1. Understand the basic principles of Surveying
2. Learn Linear and Angular measurements to arrive at solutions to basic surveying problems.
3. Employ conventional surveying data capturing techniques and process the data for computations.
4. Analyze the obtained spatial data to compute areas and volumes and draw contours to represent 3D data on plane figures.

Module-1

Introduction: Definition of surveying, Objectives and importance of surveying. Classification of surveys. Principles of surveying. Units of measurements, Surveying measurements and errors, types of errors, precision and accuracy. Classification of maps, map scale, conventional symbols, topographic maps, map layout, Survey of India Map numbering systems.

Measurement of Horizontal Distances: Measuring tape and types. Measurement using tapes, Taping on level ground and sloping ground. Errors and corrections in tape measurements, ranging of lines, direct and indirect methods of ranging, Electronic distance measurement, basic principle. Booking of tape survey work, Field book, entries, Conventional symbols, Obstacles in tape survey, Numerical problems.

Module-2

Measurement of Directions and Angles: Compass survey: Basic definitions; meridians, bearings, magnetic and True bearings. Prismatic and surveyor's compasses, temporary adjustments, declination. Quadrantal bearings, whole circle bearings, local attraction and related problems

Traversing: Traverse Survey and Computations: Latitudes and departures, rectangular coordinates, Traverse adjustments, Bowditch rule and transit rule, Numerical Problems.

Module-3

Leveling: Basic terms and definitions, Methods of leveling, Dumpy level, auto level, digital and laser levels. Curvature and refraction corrections. Booking and reduction of levels. Differential leveling, profile leveling, fly leveling, check leveling, reciprocal leveling.

Module-4

Plane Table Surveying: Plane table and accessories, Advantages and limitations of plane table survey, Orientation and methods of orientation, Methods of plotting – Radiation, Intersection, Traversing, Resection method, Two point and three point problems, Solution to two point problem by graphical method, Solution to three point problem Bessel's graphical method, Errors in plane table survey.

Module-5

Areas and Volumes: Measurement of area by dividing the area into geometrical figures, area from offsets, mid ordinate rule, trapezoidal and Simpson's one third rule, area from co-ordinates, introduction to planimeter, digital planimeter. Measurement of volumes- trapezoidal and prismoidal formula.

Contouring: Contours, Methods of contouring, Interpolation of contours, contour gradient, characteristics of contours and uses.

Course outcomes: After a successful completion of the course, the student will be able to:

1. Posses a sound knowledge of fundamental principles Geodetics
2. Measurement of vertical and horizontal plane, linear and angular dimensions to arrive at solutions to basic surveying problems.
3. Capture geodetic data to process and perform analysis for survey problems]
4. Analyse the obtained spatial data and compute areas and volumes. Represent 3D data on plane figures as contours

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. B.C. Punmia, "Surveying Vol.1", Laxmi Publications pvt. Ltd., New Delhi –2009.
2. Kanetkar T P and S V Kulkarni , Surveying and Leveling Part I, Pune VidyarthiGrihaPrakashan,1988

Reference Books:

1. S.K. Duggal, "Surveying Vol.1", Tata McGraw Hill Publishing Co. Ltd. New Delhi.2009.
2. K.R. Arora, "Surveying Vol. 1" Standard Book House, New Delhi. –2010
3. R Subramanian, Surveying and Leveling, Second edition, Oxford University Press, NewDelhi
4. A. Bannister, S. Raymond , R. Baker, "Surveying", Pearson, 7th ed., NewDelhi

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module : 1

Introduction : Definition of Surveying, objectives and Importance of surveying. classification of surveys, Principles of Surveying. units of measurements, surveying measurements and errors, types of errors, Precision and accuracy. classification of maps, map scale, conventional symbols. topographic maps. maps layout, survey of India map numbering system.

Definition of Surveying :

Surveying is the art of determing the relative positions of various points on the surface of the earth by taking various measurements.

(or)

Surveying is the art of determing the relative Positions of points on, above (or) beneath the surface of the earth by means of direct (or) Indirect measurements of distance, direction and elevation. It also Includes the art of establishing points by predetermined angular & linear measurements. The application of surveying requires skill as well as the knowledge of Mathematics, Physics, and to some extent, astronomy.

Object of survey

The primary object of a survey is the preparation of a plan or map. The results of surveys when plotted and drawn on paper constitute a plan.

A plan is therefore the representation to some scale, of the ground and the objects upon it as projected on a horizontal plane which is represented by the plane of the paper on which the plan is drawn. The representation is called a Map. if the scale is small, while it is called a plan, if the scale is large, Eg: A map of India, a plan of an estate (or) a building

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On a plan, horizontal distances only are shown. Sometimes however, vertical distances are also represented approximately by means of contour lines, and other systems. Vertical distances are correctly shown by means of vertical sections called briefly sections.

Classification of surveying

1. Primary classification:

surveying is primarily classified as follows.

(a) Geodatic surveying and.

(b) Plane surveying.

In geodatic surveying, the curvature of the earth is taken into consideration. The line joining any two points is considered as a curved line. Geodatic surveying is conducted by the "Survey Department of India" and is carried out over an area exceeding 250km2.

In plane surveying, the curvature of the earth is not taken into consideration. The line joining any two points is considered as a straight line. Plane surveying is conducted by state agencies like Irrigation department, Highway department etc. Plane surveying is done on an area of less than 250km2

All geodatic surveying include work of larger magnitude and high degree of precision.

The objective of geodatic survey is to determine the precise position on the surface of the earth, of a system of widely distant points which form control stations to which surveys of less precision may be referred.

Objectives and Importance of surveying

Objectives:

1. Collect and record data on the relative positions of points on the surface of the earth.
2. Compute areas and volumes using this data, required for various purposes.
3. To prepare the plans and maps required for various activities.

Plan: A plan may be defined as the graphical representation of the features on, near or below the surface of the earth as projected on a horizontal plane to a suitable scale.

* If the area to be represented is small, large scale can be used. such representations are called plans.

Ex: Boundary of building 1:100.

Map: A map is a symbolic depiction emphasizing distribution of earth's surface on a definite scale with annotation [note added to a text, book, drawing etc. as a comment or Explanation]

* If the area represented is large, small scale can be used. such representation are called maps.

Ex: Boundary of country 1:1000.

Importance:

1. To Prepare a Topographical map which shows hills, valleys villages, towns, forests etc of a country.
2. To Prepare a cadastral map showing the boundaries of fields, houses & other properties.
3. To Prepare a Engineering map which shows the details of work such as roads, railways, irrigation canals etc.
4. To Prepare a geological map showing areas of underground resources
5. To Prepare Route map. climatic map etc.

Surveying measurements and errors

There are two kinds of measurements used in plane surveying i.e ① Linear and ② Angular

Linear measurements may be further sub-divided into Horizontal distances & vertical distances. similarly angular measurements may be Horizontal angles & vertical angles.

In surveying all measurements of distances are Horizontal. It may be remembered that the distance blw any two ~~many~~ points on a plan ⓞr map is always the Horizontal distance blw them irrespective of their elevation.

2] Secondary classification:

1. Based on the Instruments used.
   a] chain surveying
   b] compass surveying
   c] plane table surveying
   d] Theodolite surveying
   e] Tacheometric surveying etc.
2. Based on the methods adopted. [Employed]
   a] Triangulation surveying
   b] Traverse surveying etc.
3. Based on object of surveying
   1. Engineering survey:
   2. military survey.
   3. Mine survey.
   4. Geological survey.
   5. Archaeological survey.
4. Based on Nature of field surveying
   a] Land surveying.
   b] Marine surveying.
   c] Astronomical surveying.

Further, land surveying is ~~not~~ classified as follows.

1. Topographical surveying, which is conducted to determine the natural features of a country such as rivers, streams, lakes, hills and forests as well as Man-made features like roads, railways, towns, villages and canals.
2. Cadastal Surveys: which is conducted to determine the boundaries of municipalities, states, etc. The surveys made to mark properties of Individuals also come under this category.
3. City surveys: which is conducted to locate the streets, water supply and sanitary systems etc.

2. Methods adopted:

a) Triangulation: In this method control points are established through a network of triangles.

b) Traversing: In this method Establishing control Points consist of a series of connected Points establishing through linear and angular measurements, If last line meets the starting point it is called as closed traverse. If it does not meet, it is known as open traverse

3. Based on the object of surveying

a) Engineering survey: The objective of this type of surveying is to collect data for designing roads, railways, irrigation, water supply and sewage disposal projects. These surveys may be further subdivided into.

1) Reconnaissance survey for determining feasibility and estimation of the scheme.

2) Preliminary survey for collecting more information to estimate the cost of the project. Selected and.

3) Location of survey to set out the work on the ground.

b) Military survey: This survey is meant for working out Points of strategic importance.

c) Mine survey: This is used for exploring mineral wealth.

a) Geological survey: This is survey is for finding different Strata in the earth's crust.

e) Archaeological survey: This survey is for unearthing relics of antiquity.

Based on nature of Field survey.

1) Marine (or) Hydrographic surveys:

The survey conducted to find depth of water at various Points in bodies of water like sea, river and lakes fall under this category of surveying.

Finding depth of water at specified points is known as sounding

2] Astronomical surveys:

Observations made to heavenly bodies like Sun and stars to locate absolute positions of points on the earth and for the purpose of calculating local times is known as astronomical surveys.

Applications of surveying:

Some of the important applications of surveying are listed below.

1. Astronomical survey helps in the study of astronomical movements of planets and for calculating local and standard times.
2. maps prepared for countries, states and districts, etc, avoid disputes.
3. Plans prepared record the property boundaries of private, Public and government which help in avoiding unnecessary controversies.
4. Topographical maps showing natural features like rivers, streams, hills, forests help in planning irrigation projects and flood control measures.
5. Road maps help travellers and tourists to their programmes
6. Marine and hydrographic surveys helps in planning navigation routes and harbours.
7. Military surveys helps in strategic planning.
8. For Exploring mineral wealth mine surveys are required
9. Geological surveys are necessary for determining different strata in the earth's crust so that proper location is found for reservoirs.
10. Archaeological surveys are required for unearthing relics of antiquity.

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Basic Principles of Surveying:

The Two fundamental principles upon which various survey Methods are based are.

1. To work from whole to the part. and.
2. To locate a point by atleast two measurements.

1 To work from whole to the part:-

The main idea of this principle is to localise the errors and to prevent their accumulation. on the contrary, if we work from part to the whole, the errors accumulate and expand to a greater magnitude.

This principle is Explained in the following Example.

Let a line AB is to be measured with a chain. Since the length of the chain is smaller than the distance to be measured. the process of measurement is done in parts as reference. Let C. D. E. etc. are ranged taking the points A and B. Out of line AB as D', only the distance CD and DE will be erroneous as CD' and D'E. But all other distances are correct [Ref fig. 14]

In the other method, [working from Part to whole]. a part say AC of the whole distance. AB to be measured, is fixed by locating a point C as C'. Now if the remaining points D', E' etc. taking A and C' as reference, the error at the end will be of higher magnitude.

[Ref. fig. 15].

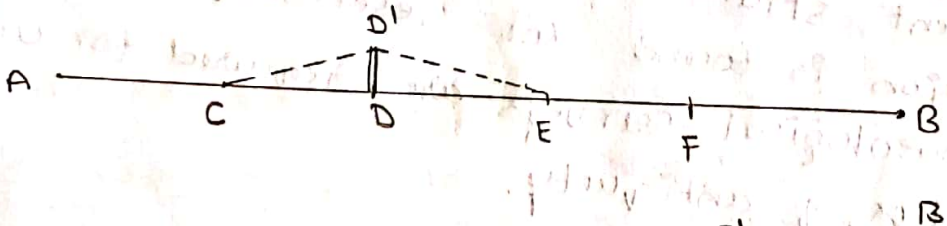

Fig. 1.a

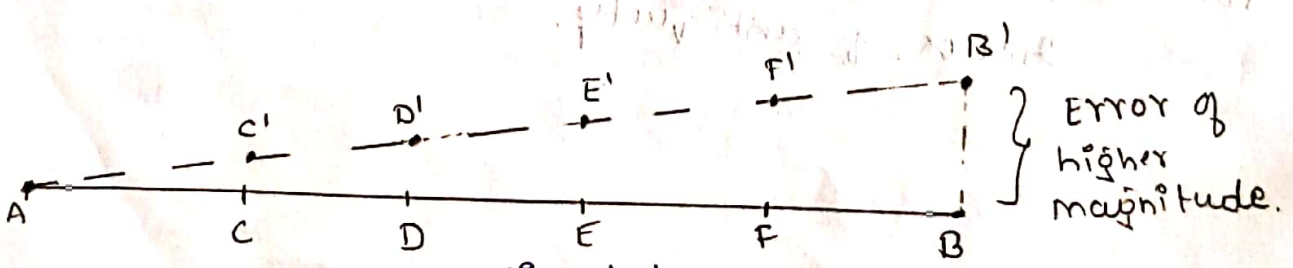

Fig. 1.b

2] Location of a Point by two observation:

The relative positions of points are located by measurement from atleast two points of reference, whose positions must be known.

For Example: In Figures 2a, 2b, 2c and 2d, A and B are the two control points, whose positions are already known. The position of point C. can be obtained by any one of the followlug Method.

a] By measuricug a distance say BC and an angle say α [Ref Fig. 2a]

b] By measuring two distance say AC and BC [Ref Fig. 2b]

c] By measuring two angles say α_1 and α_2 [Ref Fig 2.c]

d] By dropping perpendicular from C on line AB and measuring two distances like AD and CD (or) BD and CD [Ref. fig 2d]

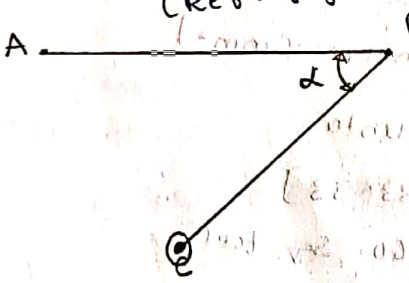

Fig. 2a

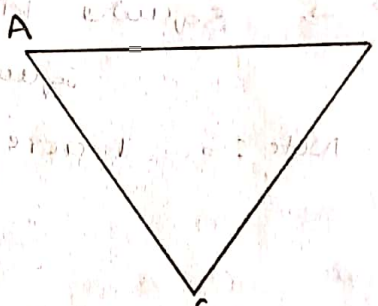

Fig 2.b

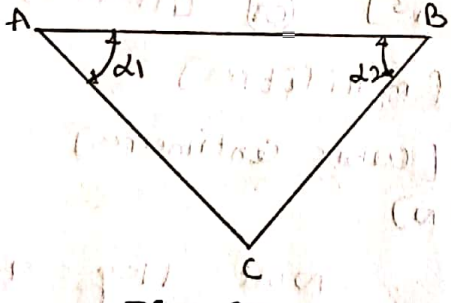

Fig. 2c

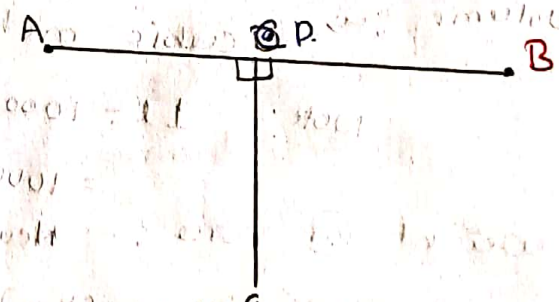

Fig. 2d

Units of Measurements :

In 1956 according to standards of weights and measurement Act., There are four kinds of measurements used in plane surveying.

1. Horizontal distance.
2. Vertical distance.
3. Horizontal angle
4. Vertical angle.

Linear measures :

According to the standards of weights and measures act [India], 1956 the unit of measurements of distance is metres & centimetres.

1. Length : → Metre [m] (or) kilometre [km] (or) millimetre [mm]

Note: 1 M = 3.2808 feet [3.3 feet approx]

2. Area : → Square kilometer [km^2] (or) Square metre [m^2] or Square millimetre [mm^2]

Note :→ 1 acre = 40 guntas
= 40 × [33×33]
= 43,560 Sq. feet.

1 acre = 4046.86 m^2.

3. Volume : → cubic metres [m^3] (or) Litres [l]

Note: 1 l = 1000 ml [milli Litres]
= 1000 cc [cubic Centimetres]

4. Weight (or) Force : - Newton [N]

Mass : kilogramme [kg]

Note: 1kg = 9.81 N

Angular measure: An angle is the difference in direction of two intersecting lines. The radian is the unit of plane angle. The radian is the angle blw two radii of a circle which cuts-off on the circumference of an arc equal in length to the radius. There are three popular systems of angular measurement

Angular measure: Radians [rad] or degrees [°]

a] Sexagesimal system.

1 circumference = 360° [degrees of arc]
2. 1 degree = 60' [minutes of arc]
3. 1 minute = 60" [seconds of arc]

b] Centesimal system.

1 circumference = 400g [grads]
1 grad = 100c [centigrads]
1 centigrad = 100cc [centi-centigrads]

c) Hours system

1 circumference = 24h [hours]
1 hour = 60m [minutes of time]
1 minute = 60s [seconds of time]

Errors:

Error is the difference b/w the measured quantity and its true value.

Error = measured value - True value.

Depending upon the magnitude of measured value, compared to its true value, an error may be positive or negative.

Sources of errors:

1. Instrumental: Error may arise due to imperfection or faculty adjustment of the Instrument with which measurement is taken.

For Example: A tape may be too long, or an angle measuring Instrument may be out of adjustment.

Such error are known as Instrumental errors.

2) Personal error: Error may also arise due to imperfection of human sight in observationing & of touch in manipulating Instrument.

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For Example: An error may be there in taking the level reading (or) reading an angle on the circle of a Theodolite. Such errors are known as personal errors.

3. Natural Errors:

Error may also be due to variations in natural Phenomena such as temperature, humidity, gravity, wind, Refraction and magnetic declination. If they are not Properly observed while taking measurements, the results will be incorrect.

For Example: A tape may be 20 m at 20°c. but its length will change if the field temperature is different.

Types of errors: [Kinds of errors]

Errors have been classified into the following three types.

1. Mistake.
2. Systematic error.
3. Accidental error.

(1) Mistake:

Mistake are the errors due to carelessness of the Observation ver. They may be due to wrong reading (or) recording of the observations. These errors are very large and can be easily detected by the following field Procedures.

a] Carefully targeting objects before taking reading.
b] Taking multiple scale readings.
c] Recorder loudly announcing the readings so that reader hears what he records.
d] Taking additional readings for checking

(2) Systematic error:

The errors which are Systematic (or) follow some pattern are termed as Systematic errors. Such errors are always according to some deterministic System and can be Expressed by a functional Relationship.

Measurement of a distance by a too short tape and Expansion of a steel tape with respect to temperature are the Example of Systematic errors. Such errors can be computed using certain mathematical Relationships and the measurement can be corrected.

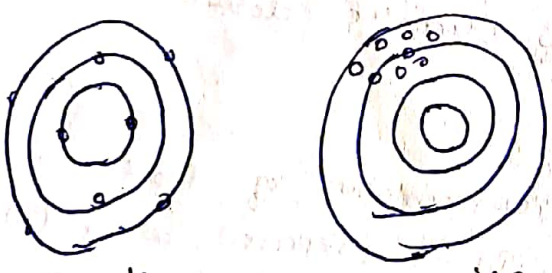
③ Accidental errors:

After the measurements are corrected for known systematic errors. if still some error exists. it is accidental error. Accidental errors do not have any functional relationship and have random behaviour and hence are also known as "Random errors". These errors are unpredicable in magnitude & algebraic sign. Random errors can be corrected based on probabacity models.

Accuracy and Precise

- **Accuracy**: It is defined as correctness/degree of perfectness in reaching an intended target.
  In surveying intended target is the true value of measurements.
  Intended accuracy is the maximum permissible error.

- **Precise**: It means being careful about details and accuracy. Hence precision is the degree of perfection used in Instruments and the methods of observation and calculation.



a) Accurate. b) Precise

Precision: It is the degree of closeness (or) confirmity of repeated measurements of the same quantity to each other.

Accuray: It is the degree of closeness (or) confirmity of a measurement to its true value.

The difference blw accuracy & precision is best ustrated in fig. i.e. results of a shooting competition blw contestents A. B. C & D. The shooting results indicate.

① contestent A is accurate but not precise.
② coutestant B is inaccurate but not precise.
③ contestant C is neither accurate nor precise. &
④ contestant D, the winner, is both accurate and Precise.

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Map and classification

A map is a graphical representation of the earth surface as projected on a horizontal plane. It is prepared to a small scale. (ie very large actual distance is represented by a very small line segment). Hence the map can show the area as a whole and cannot reveal the details of the features. On a map the topography of the terrain is depicted by colour (or) hatching. Dimensions are not shown on the map.

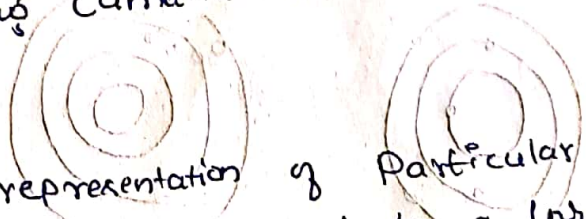
Maps are classified as follows.

1. Physical maps; showing various areas.
   Ex: world map – showing continents & countries.
   country map. showing districts and important places. state maps, citymaps etc
2. Topographical features:
   showing the details of topographical features like hills, valleys etc.
3. Route maps:- showing details of communication routes like Roads, railways etc.
4. Geological maps: showing areas of underground resources.
5. Archeological maps: showing places of ancient relics.
6. climatic maps: showing climatic details etc.

e:

Plan is also a graphical representation of particular feature s projected on a horizontal plane. It is prepared to a large scale compared to a map. Plan reveals the details of a particular feature. It shows the dimensions of the features

Ex: plan of a building



testant A

Accurate
imprecise

contestant B

Inaccurate
precise

contestant C

Inaccurate
Imprecise

contestant D

Accurate
precise.

SCALE: It is defined as the ratio of the distance b/w two points on a map to the corresponding distance on the ground. Selection of a scale depends on the size of the area to be surveyed, purpose of survey and required precision in plotting.

- Maps are generally classified as large scale when the scale is greater than 1cm = 10m, as intermediate scale when the scale is b/w 1cm = 10m & 1cm = 100m, and as small scale when the scale is less than 1cm = 100m.

Representation of Scale:

1. A scale can be represented numerically (or) graphically. For example 1cm = 50m, according to this scale a specified distance on the map [i.e. 1cm] representing the corresponding distance on ground. [i.e. 50m].
2. The other way to indicate the scale by a ratio known as Representative fraction, abbreviated as R.F for the scale 1cm = 50m, $R.F = \frac{1cm}{(50cm \times 100)cm} = \frac{1}{5000}$ i.e 1:5000

Scales for different types of surveys.

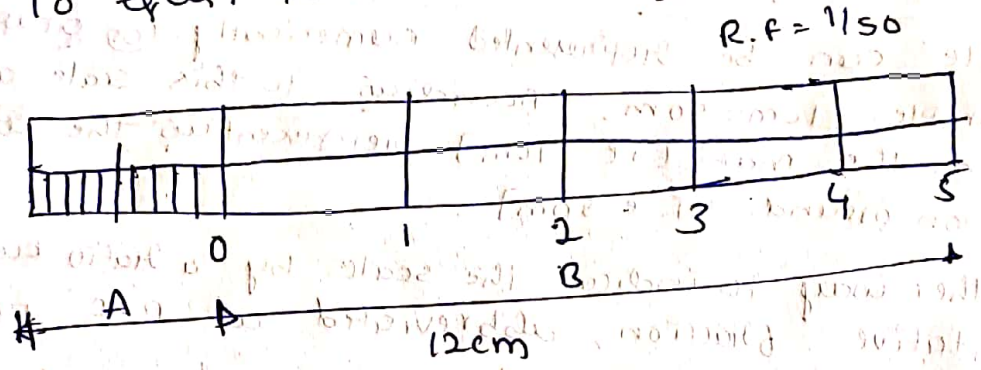
Purpose of Survey	Scale	R. F.
Building sites	1cm = 10m (or) less	1:100 (or) $\frac{1}{100}$ (or) less
Town planning, reservoir survey etc.	1cm = 50m to 100m	$\frac{1}{5000}$ to $\frac{1}{10000}$
Route surveys	1cm = 100m	$\frac{1}{10000}$
Land surveys	1cm = 50m to 200m	$\frac{1}{5000}$ to $\frac{1}{20000}$
topographical surveys	1cm = 0.25km to 2.5km	$\frac{1}{25,000}$ to $\frac{1}{2,50,00}$
Geographic surveys	1cm = 5km to 150km	$\frac{1}{500000}$ to $\frac{1}{150,00,00}$

* If R.F for a scale is 1:50 & max distance to be measured using the scale is 6m, then to construct a plain scale, steps to be followed are.

50 units on the ground = 1 units on the map.

6m on the ground = $\frac{6}{50}$ m on the map = 12cm on the map.

Draw a line of 12cm, & divide it equally into 6 parts. The first part A on the left side is further divided into 10 equal parts to read $\frac{1}{10}$ m.



1. SURVEY OF INDIA

1.1 Introduction

Survey of India is the National Survey and Mapping Organization of our country. It was established in 1767. It's responsibilities are as follows:

a) All geodetic control (Horizontal and vertical) and geodetic surveys (including tide predictions for 40 ports in the Indian Ocean, Arabian Sea and Bay of Bengal, in the region from Suez to Singapore)) and allied geophysical surveys.
b) All topographical control surveys and mapping within India.
c) Mapping and productions of geographical maps and aeronautical charts.
d) Surveys for development projects.
e) Survey of forests, cantonments, large scale city surveys, guide maps, etc.
f) Survey and mapping of special maps, eg. Riverain areas and geographical explorations authorised by the Government of India.
g) Spellings of geographical names.
h) Demarcation of the external boundaries of the Republic of India, their depiction on maps published in the country and also advice on the demarcation of inter-state boundaries.
i) Training of officers and staff required for the department and state and trainees from Central Government Departments and State and trainees from foreign countries as are sponsored by the Government of India.
j) Research and development in cartography, printing, geodesy, photogrammetry, topographical surveys and indigenisation.
k) Co-ordination and control in providing photographic cover over the whole of the country.

1.2 Types of Survey of India Maps

Topographical Maps

These are the maps that are prepared on sufficiently large scale to enable individual topographical details to be identified on the ground by their position and shapes. The scales of topographical maps are 1:25,000, 1:50,000, 1:250,000.

Geographical Maps

These are the maps prepared on scales smaller than 1:250,000 in which details and features of ground are generalised. The following are some of the geographical maps published by Survey of India.

1) 1:1M India and Adjacent Countries Series.
2) 1:1M Carte International du monde (International Maps of the world)
3) 1:1M Aeronautical maps.
4) 1:1M State Maps.
5) 1:2M South Asian Series.
6) Wall Map of India and Adjacent countries on Scales 1" = 40 miles; 1:2.5M; 1:4M; 1:8M; 1:16M.

Special Maps

These are prepared for popularisation drives such as Tourist Maps, Antique maps, Discover India Series. State Map Series are also available on 1:1 M scale.
Special maps also include:
1:3.5M Railway Map of India
1:2.5M Road Map of India
1:25,000, 1:50,000 Forest maps
1:10,000, 1:20,000, 1:25,000 Guide Maps

Plastic Relief Maps:
Survey of India also has Plastic Relief Maps of
India Physical on 1:15M
India Political on 1:15M
Route Map from Rishikesh to Badrinath on 1:250,000
District Planning Map Series: on 1:250,000 scale
Trekking maps are also available on scale 1:250,000. State Map Series in local languages are also in progress.

2. Maps

2.1 Definition

A map is a selective, symbolised, generalised and planimetric picture of spatial distribution of earth's surface on a definite scale with anotation.

2.2 Fundamental characteristics of map

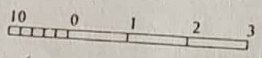
The above definition of a map leads us to some fundamental characteristics of map which are as below.

a) Every map should have reference system.
b) Every map is made on a certain projection.
c) Every map is drawn to a definite scale.
d) A map has to be selective in showing details.
e) Certain feature / information is emphasised.
f) Every map is generalised.
g) Every map uses symbols.
h) Maps are lettered, titled and labelled.

2.3 Scale

Scale of a map is the ratio of distance on the map to the actual distance on the ground. To show features to varying degree of details, maps are prepared on different scale. Scales may be expressed in three different ways.

i) Representative Fraction (R.F.): 1 : 50,000
ii) Comparitive statement : 1 cm =50 Km
iii) Graphical method. :



2.4 Generalisation

The smaller the scale of map, greater the degree of generalisation. It consists of the following processes – selection, simplification, omission, aggregation, exaggeration, symbolisation and displacement. While doing generalisation, the basic character of the terrain is retained. It is to a large extent a subjective exercise.

2.5 Emphasis

Very often certain features and information which are important and necessary with the special purpose are emphasised on the map and other features are kept subdued or thinned down to facilitate map reading.

2.6 Semiology

Semiology is the study of signs or symbols. A symbol is any drawn or constructed image used as a means of communication. The symbol on a map consists of points, lines or areas. The symbols can have different size, form and colour. The symbol contains information individually and can also present information collectively. The graphic variation distinguishes one symbol from the other. These graphic variations have to be employed in relation to the information represented.

mbol Types:

Symbols can be classified into point, line and area symbols.

) Point symbols:

These are used to indicate the location, identity or other characteristics of features of small territorial extent to the map scale. A city will be indicated by a point symbol on 1:1M, but this would never be the case at a scale 1: 1,000.

Example: Hut, Tube well, Mosque.

ne symbols:

se are used where the feature to be represented as a linear characteristic.

River, Road and railway.

mbols:

used to represent features of considerable areal extent in relation to scale of map.

villages, tanks, cultivation lands.

Point Symbol		Linear Information/Symbol	Areal Symbol	Textual Information
Temple		Metalled Road, NH	Towns or Villages	Name CHENNAI BANGALORE
Mosque		Metalled Road, SH With bridge	Tanks: Perennial, dry	Heights 1510 .3r
Church		Railways, Broad guage With Rly. Stn.	Orchard or Garden	Descriptive Open Scrub Remarks :
Tree		Footpath with bridge	Camping ground CG	Locality : Bommanahalli
Chimney	• chy	International boundary	Vine on trellies	Admn. Names : ANEKAL

Qualitative and Quantitative symbols:

Qualitative symbols deal with the quality. They indicate the identity or describe the nature of the feature.

Quantitative symbols indicate the quantity of the feature or give the amount of feature.

Both these qualitative and quantitative symbols can take the form of point, line and area symbols.

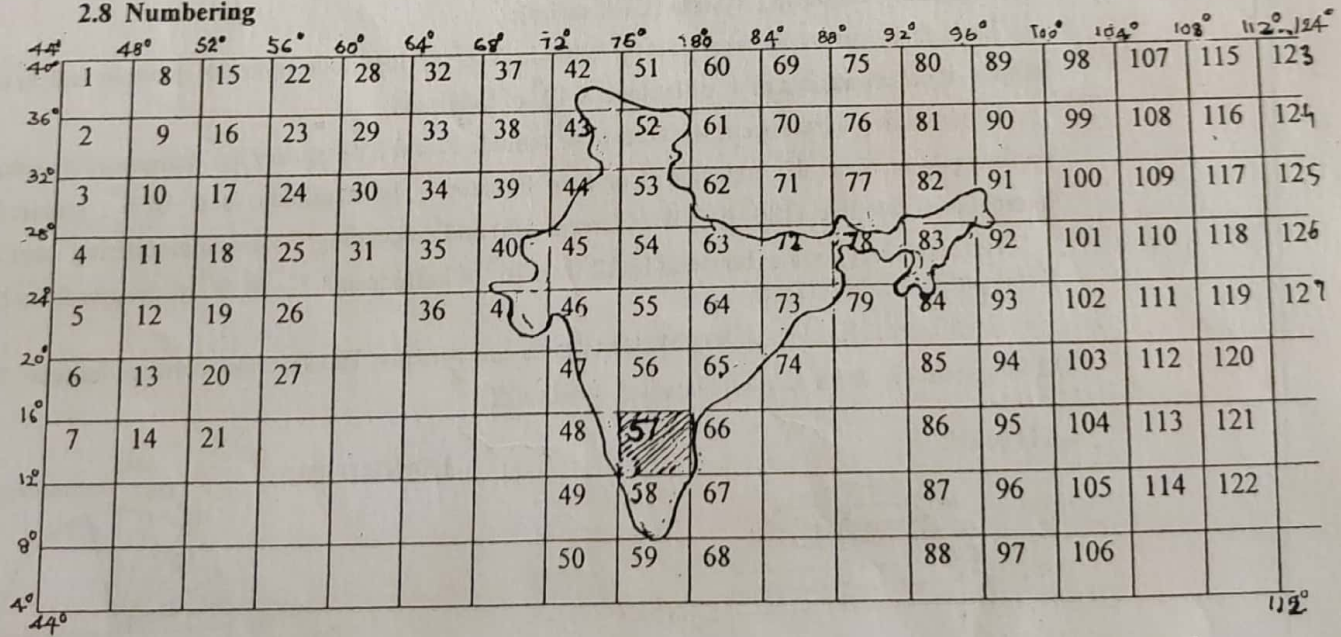
Representation of Details

Symbols / conventional signs for all details suitable for our topo maps have been standardised and printed as a table on our map. It would be readily apparent that conventional symbols represent only the qualitative aspect of the feature ie. A double line road whose width is 0.60 mm on the 1:50,000 map does not mean that the road is actually 0.60 x 50= 30 m wide on the ground .The road is just represented conventionally. If it were to be represented to its true dimension, then the symbol would be thinner and insignificant. But in large scale, where it may be feasible to survey each edge of the road seperately it would be shown as such. Hence the need of having different symbols for different scale.

2.7 Lettering

All information to be supplied through map cannot be rendered through graphic alone. One has to use texts and lettering to describe names not feature ie. Village, towns, rivers, forests, and descriptive remarks, values of contour lines, heights, distance stone number etc. Border information, marginal informations, titles, symbols tables scale etc. use text. Texts are available on different fonts, sizes and styles which are to be planned before entering on a map. Texts add beauty and meaning to maps and thus form an important component.

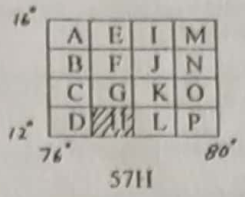
2.8 Numbering



The India and adjacent countries map is bounded by 4° to 40° of latitude and 44° to 124° of longitude. The area covered by the above map has been divided into 4° belt of latitude and 4° of longitude and each square is serially numbered starting from NW corner to down South and to Eastwards. These sheets are known as 1:1 M or Million sheets.

For example, the sheet covering an area bounded by 12° to 16° of latitude and 76° to 80° of longitude is 57.

The 1:1 M sheets is further divided into 16 equal parts of 1° latitude X 1° longitude. This sheet is also known as degree sheet or 1:250,000 sheet. Each of these sheets is numbered from A to P alongwith the serial number of 1:1 M sheet. Thus 57H sheet covers an area of 12° to 13° of latitude and 77° to 78° of longitude.

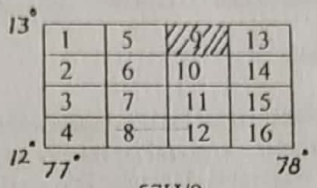


57H

1: 50,000 Scale Sheet:

A degree sheet is again subdivided into 16 equal parts each of 15' latitude X 15' longitude in extent. These sheets are numbered from 1 to 16 .Thus the sheet on 1:50,000 scale forming a part of 57H will be numbered as 57H/1, 57H/2, 57H/3 and so on.

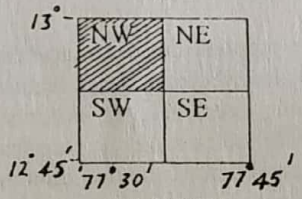
Example: Sheet shown by hachures will be numbered as 57H/9.



57H/9

1:25,000 Scale Sheet:

1:50,000 scale sheets are further subdivided into 4 equal parts, each of 7½' latitude X 7½' longitude. These sheets are numbered as 57H/NW, 57H/NE etc. as shown below. The scale of these sheets is 1:25,000.



57H/9/NW

International Numbering System (CIM series):

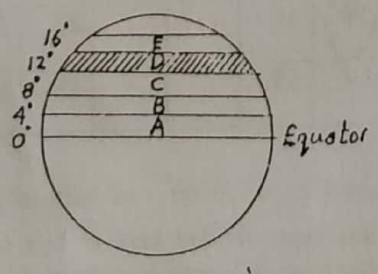
Each sheet covers an area from 4° latitude X 6° of longitude upto 60° latitude and beyond 60° latitude, it covers an area of 4° of latitude X 12° of longitude.

In numbering these sheets, the belts of 4° latitude N and S of equator are designated by letter A to X prefixing N or S, as the area lies N or S of Equator. The longitude belt of 6° recons from the international date line (180° E or W of Greenwich) and proceeding Eastward numbering from 1 to 60.

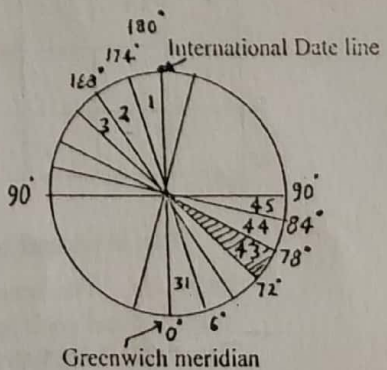
Thus the sheet number bounded by 12° and 16° of latitude and 72° & 78° of longitude in Northern Hemisphere will be ND : 43

Each International sheet has 24 sheets as its components. The sheet no. between latitude 12° & 13° and longitude 77° & 78°E of Greenwhich is ND 43X.

LATITUDE



LONGITUDE



Measurement of Horizontal distance:

* Tapes and types:

The following are the different types of tapes.

1. Cloth (or) linen tape
2. Metallic tape.
3. Steel tape.
4. Invar tape.

Raghu M.E
Assistant Professor
Civil Department
B.I.E.T
Davanagere.

1. Cloth (or) linen tape:

Cloth tapes ~~tapes~~ of closely woven linen (or) synethic materials and is varnished to resist moisture, are light and flexible and may be used for taking comparatively rough and subsidiary measurements such as offsets. A cloth tape is commonly available in lengths of 10m, 20m, 25m & 30m and in 33 feet, 50 feet, 66 ft and 100 feet. The end of the tape is provided with small brass ring whose length is included in the total length of the tape.

A cloth tape is rarely used for making accurate measure-ments. because of the following reasons.

(1) It is easily affected by moisture (or) dampness and thus shrinks.
(2) its length gets altered by stretching
(3) It is likely to twist and tangle. and.
(4) It is not strong.

Before winding up the tape in the case. it should be clean and dried.

Metallic tape: A metallic tape is made of varnished strip of water proof linen interwoven with small brass, copper (or) bronze wires & does not stretch as easily as cloth tape.

Since metallic tapes are light and flexible and are not easily broken, they are particularly useful in cross sectioning and in some methods of topography (or) ~~or~~ all commonly used for small survey works.
This tape is available in lengths of 15, 20 & 30m & 50 m lengths are supplied in a metal (or) leather case fitted with a winding device.

3. Steel tape: This is made of steel ribbon of width varying from 6 to 16mm. It is graduated in metres, decimetres and centimetres.
It is commonly available in lengths of 10, 15, 20, 30 & 50m, It is generally used for standardising chains and for measurements in constructional works.

4. Invar tape:

Invar tape is made of an alloy of steel (64%) and nickel (36%). Its thermal co-efficient is very low (0.122×10^{-6} / C°). Hence it is not affected by changes temperature. It is available in length of 30m, 50m & 100m & in a width of 6mm. It is used at places where maximum precision is required and generally used in triangulation survey conducted by the survey Dept of India.

Ranging a Line:

The process of locating intermediate points on a straight line b/w two end points in the field is known as "Ranging". Ranging is done prior to chaining.

Ranging is of two kinds, namely

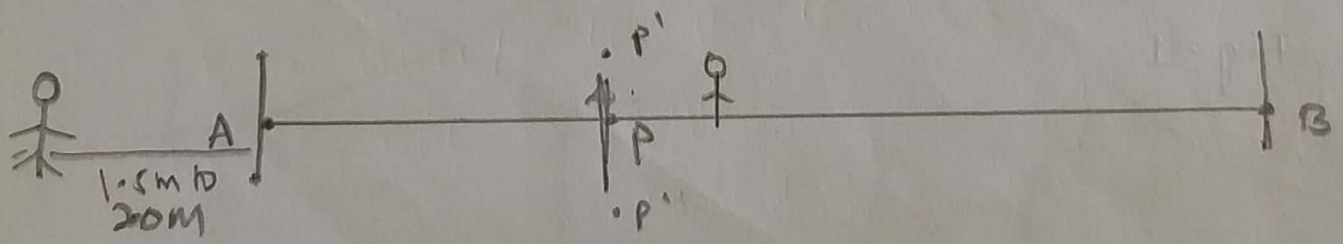
1. Direct ranging.
2. Indirect ranging.

1. Direct ranging:

when intermediate ranging rods are fixed on a straight line by direct observations from end stations, the process is known as "direct ranging". Direct ranging is possible when the end stations are intervisible. Direct ranging can be done either by "eye" (or) by using "Line ranger".

a) Ranging by Eye:

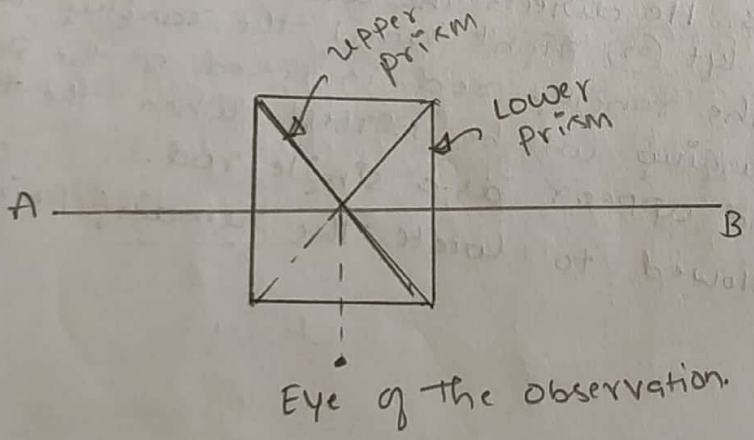
In Fig.1 A and B are two end stations of a chain line, where two ranging rods are already fixed. The surveyor stands about 1.5 - 2m behind ranging rod at A by looking towards the line AB. He directs the assistant, holding the ranging rod to move to the left (or) right until the ranging rod comes in the line AB. The ranging rod is fixed at the point so obtained. Say P. The ranging will be perfect, when the three ranging rods coincide and appear as a single rod.
The same procedure is followed to locate the remaining points.



(b) Ranging by line Ranger :

The line Ranger consists of two right angled Isosceles triangular prisms, placed one above the other as shown in fig. 1. The reflecting surfaces of the two prisms are normal to each other. It is a handy reflecting Instrument, used for locating intermediate points on a straight line.

Let a points P is to be fixed in line blw the ranging rods A and B. The observer holding the line ranger at the eye level stands newly at P and looks through the line ranger. The observer seen the images of two ranging rods in the upper and lower prisms. If the two images appear seperate ~~then~~ (fig), the observer is not in the line AB. He then moves forward and backward till the two images appear as one line [Fig 1.5] The required point P is then vertically ~~blw~~ below the centre of Instrument.



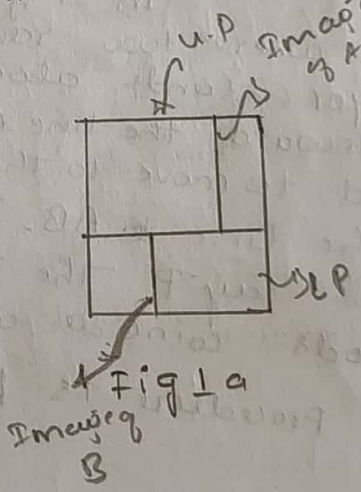


Fig 1a

Fig 1b

[Correct Point

Fig. 1.

② In Direct ranging : [OR Reciprocal Ranging]

When the two end stations are not intervisible due to a high ground blw them, Intermediate points are located on the line by indirect method. This method is known as "Indirect ranging" (or) "Reciprocal Ranging".

The following procedure is adopted for Indirect ranging.

Let A and B be the end stations, which are not intervisible due to a high ground blw them. (Ref. following fig)

Two chain men take up positions at R_1 and S_1 with ranging rods in their hands. The chainman at R_1 stands with his face towards B, so that he can see the ranging rods at S_1 and B.

Again, the chainman at S_1 stands with his face towards A, so that he can see the ranging rods at R_1 and A.

The chainman at R_1, directs the chainman at S_1 to come to the position S_2, so that $R_1 S_2$ and B are in the same straight line. Now the chainman at S_2 directs the chainman at R_1 to move to the position R_2, so that S_2, R_2 and A are in the same straight line. By directing each other alternately in this manner, they change their positions every time until they finally come to the positions R and S, which are in the straight line AB.

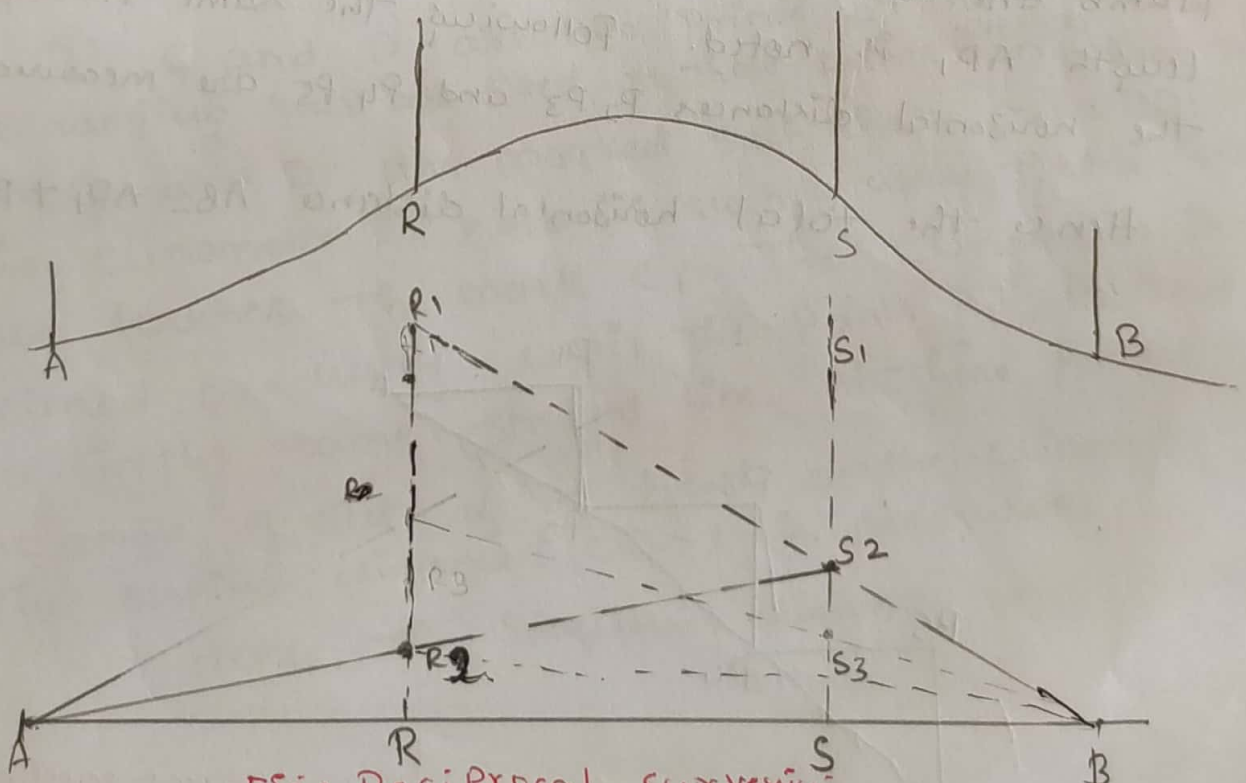


Fig: Reciprocal surveying.

② Measurement of Distances over sloping Ground:

Horizontal distances are required in surveying. Hence in chaining along a sloping ground, the horizontal distance blw two stations are measured carefully by applying some convenient methods. The following methods are generally adopted.

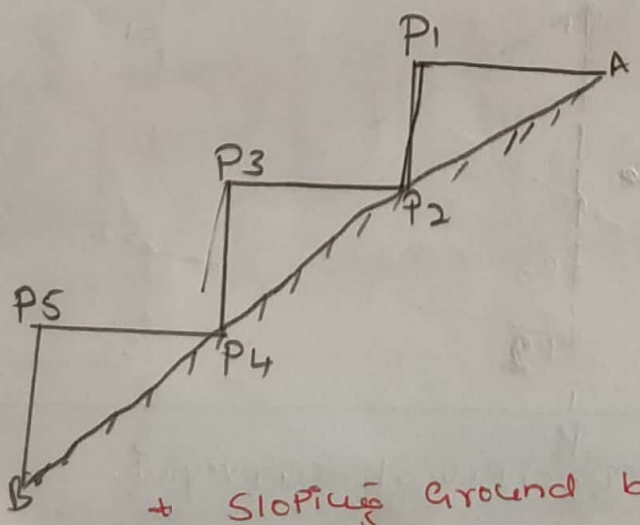
a) Direct method.

b) In Direct method.

a) Direct Method:

This method is adopted, when the slope is very steep. In this method, the sloping ground is divided into a number of horizontal and vertical strips like steps. Hence this method is also known as the stepping method. the lengths of the horizontal positions are measured and added to get the total horizontal distance. The Procedure of measuring horizontal distance along the sloping ground is as follows (Ref: fig). The follower holds the zero end of the tape at A. The leader selects a suitable length AP_1 so that AP_1 is just horizontal. The horizontality is maintained by "eye estimation" (a) Tri-square. The point P_2 is marked on the ground by Plumb ~~line~~ bob so that P_1 is just over P_2. The horizontal length AP_1 is noted. Following the same procedure the horizontal distances P_2P_3 and P_4P_5 are measured.

Hence the total horizontal distance $AB = AP_1 + P_2P_3 + P_4P_5$.



+ Sloping Ground by Direct method.

b] Indirect Method:

When the slope of the ground surface is long and gentle, the stepping method is not suitable. In such a case, the horizontal distance may be obtained by the following procedures.

1] By measuring slope with clinometer
2] By applying hypotenusal allowance and.
3) By knowing difference in level blw point.

1] Measuring slope with clinometer

A clinometer is a graduated semicircular protractor. It consists of two pins P_1 and P_2 [Refer fig] for sighting the object. A plumb bob is suspended from point O. when the "Diametrical axis" is just horizontal, the thread of plumb bob passes through O. when the "diametrical axis" is tilted, the thread remains vertical, but passes through a graduation on the arc which shows the angle of slope.

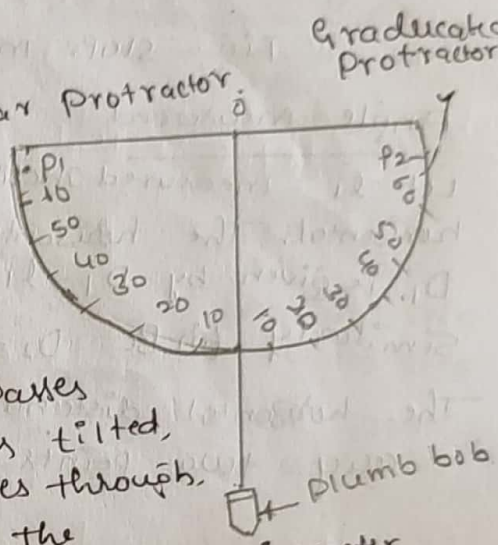


Fig: Clinometer

If C and D are two points on the sloping ground, two ranging rods are fixed at these points. (Ref fig 2) The clinometer is held in such a way that its centre O, rods C_1 and D_1 are marked such that $CC_1 = DD_1$. Just touches the mark C_1. The clinometer is then Inclined gradually until the points P_1, P_2 and D_1 are in the same straight line. At these position, The angle of slope α is read on the clinometer. The sloping distance $CD = l$ is measured.

Hence, the required distance $= CD' = l\cos\alpha$.

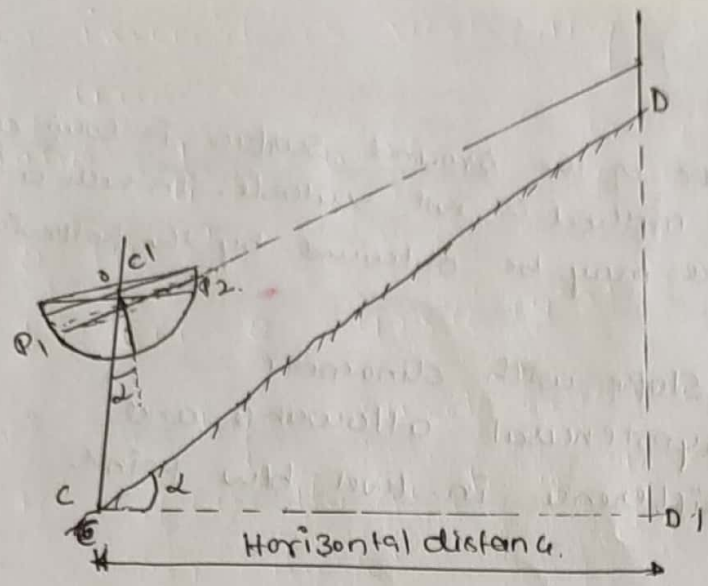


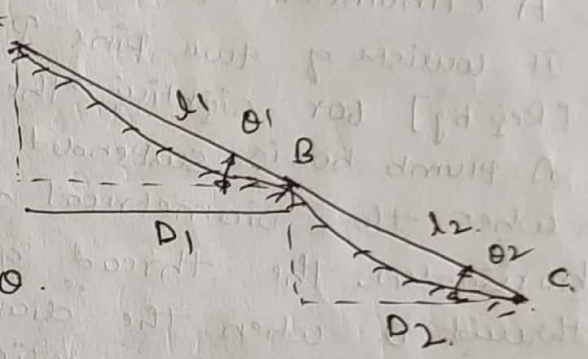
Fig: Slope measurement with clinometer.

Angle measured

Let l_1 = measured inclined distance b/w AB and θ_1 = slope of AB with horizontal. The horizontal distance D_1 is given by $D_1 = l_1 \cos\theta_1$

Similarly for BC $D_2 = l_2 \cos\theta_2$

The horizontal distance b/w any two points $= \Sigma l \cos\theta$.



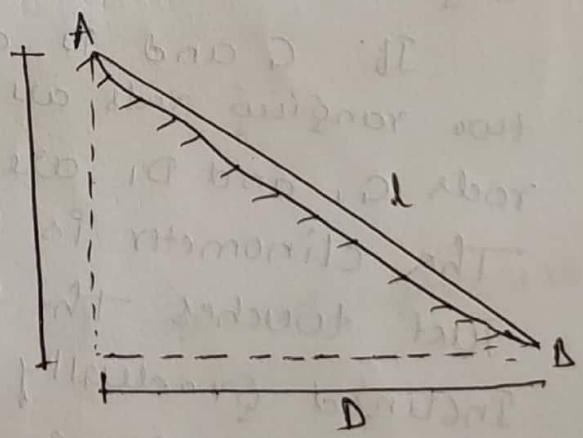
Method 2. Difference in level measurement:

In this method, the sloping distance l and difference in levels h are measured [Ref fig]

Then the horizontal distance are given by

$D = AB = \sqrt{l^2 - h^2}$

$$\boxed{D = \sqrt{l^2 - h^2}}$$



Method: 3 Hypotenusal allowance:

In this method, the slope of the ground θ is first measured with clinometer in fig.

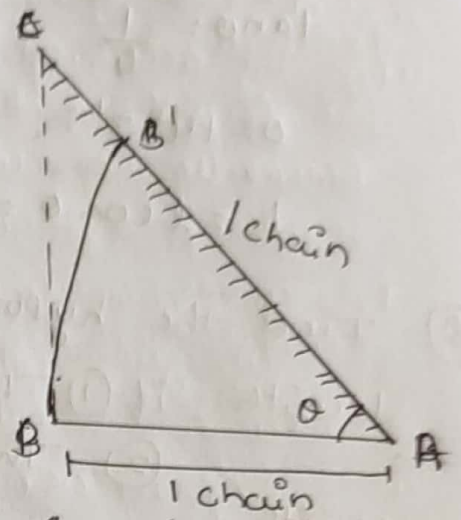


Fig: Hypotenusal allowance.

Let AB = AB' = 20m = 100 Links

AC = AB sec θ = 100 sec θ

B'C = AC - AB'

= 100 · sec θ - 100

= 100 [sec θ - 1] Links

B'C = 100 [sec θ - 1] Links

The amount 100 [sec θ - 1] is called "Hypotenusal allowance".

$\sec\theta = \frac{AC}{AB}$

$AC = AB \cdot \sec\theta$

$AC = 100 \cdot \sec\theta$

while chaining along the slope, one chain would be actually located at B'. But the arrow is placed at C after making hypotenusal allowance. The next chain will start from C. The same principle is followed until the end of the line is reached.

Problems 1. The distance blw the points measured along a slope is 428m. Find the horizontal distance blw them if,
a) The angle of slope blw the points is 8°,
b) The difference in level is 62m.
c) the slope is 1 in 4.

Sol. Let (a) D = horizontal length, l = measured length = 428m

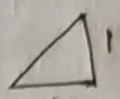
$D = l\cos\theta = 428 \cos 8^\circ$

$D = 423.834M$

(b) $D = \sqrt{l^2 - h^2}$ $D = \sqrt{428^2 - 62^2}$

$D = 423.4PM$

c] For 1 unit is vertically, horizontal distance is 4 units



$\tan\theta = \frac{1}{4} = 0.25$

$\theta = 14°2'$

$L = l\cos\theta = 428\cos 14°2' = 415.22\text{m}$

② Find the hypotenusal allowance per chain of 20m length if ① The angle of slope is 10° ② The ground fixed by 4m in one chain length

Soln ① Hypotenusal allowance $= 100[\sec\theta - 1]$ links

$= 100[\sec 10 - 1]$

$= 1.54$ links

$= 0.31\text{m}$

$\tan\theta = \frac{4}{20} = \frac{1}{5} = 0.2$

$\theta = 11°19'$

② Hypotenusal allowance $= 100[\sec 11°19' - 1]$ links

$= 1.987$ links.

$= 0.4\text{m}$

Tape Corrections

Accurate measurements of distance is made by means of a steel tape of 30m (or) 50m (or) 100m length. Depending upon the accuracy required in the measurement, certain corrections are applied to the measured distance.

The following corrections are applied to the measured length of a line to obtain its true length.

1. correction for absolute length.
2. correction for temperature.
3. correction for pull (or) tension.
4. correction for sag.
5. correction for slope.
6. correction for alignment
7. correction for sea level.
8. correction to measurement in vertical plane.

Correction for absolute length (C_a):

If the actual length of the tape (or) wire is not equal to its nominal (or) designated length, a correction will have to be applied to the measured length of the line.

If the actual length of the tape is greater than the nominal (or) The designated length, the measured distance will be short and the correction will be additive.

If the actual length of the tape is lesser than the nominal length. The measured distance will be too great and the correction will be subtractive.

$$C_a = \frac{L.C}{l}$$

C_a = correction for absolute length.

L = measured length of the line

C = correction per tape length.

l = designated length of the tape.

C_a will be of the same sign as that of C

(2) Correction for Temperature:

If the temperature in the field is more than the temperature at which the tape was standardised, the length of the tape increases, measured distance become less. and the correction is therefore additive, Similarly, If the temperature is less, the length of the tape decreases. Measured distance becomes more & the correction is negative.

The correction is given by

$$C_t = \alpha [T_m - T_o] L$$

α = ~~Thermal~~ co-efficient of thermal Expansion

T_m = Mean temperature in the field during measurement.

T_o = Temperature during standardisation of the tape.

L = Measured length

$\alpha = 11.4 \times 10^{-6}$ / °C for steel tape

$\alpha = 6.3 \times 10^{-7}$ / °C for invar tape

$$C_t(\text{brass}) = \frac{\alpha_b [L_s - L_b]}{\alpha_b - \alpha_s}$$

$$C_t[\text{steel}] = \frac{\alpha_s [l_s - L_b]}{\alpha_b - \alpha_s}$$

} Jaderin's method.

sign C_t is positive when $T > T_o$ (greater)

negative $T < T_o$ (Lesser than)

(3) Correction for Pull or Tension:

If the Pull applied during measurement is more than the pull at which the tape was standardised, the length of tape increases, Measured distance become less, and the correction is positive, Similarly, If the Pull is less, the length of the tape decreases. Measured distance become more and the correction is negative

$$\text{If } C_P = \frac{[P - P_o]L}{AE}$$

Sign C_P is positive when $P > P_o$ and negative. when $P < P_o$

P = Pull applied during measurement (N)

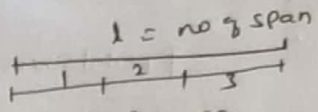
P_o = Standard Pull (N)

L = Measured length (m)

A = Cross-sectional area of the tape (m^2)

E = Young's modulus of Elasticity (N/m^2)

4. Correction for sag : [C_s]



$$C_s = \frac{l[w^2]}{24n^2p^2}$$

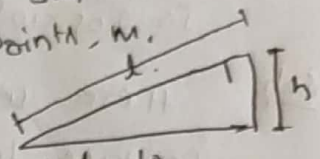
l = length of tape, m
w = weight of tape, N
n = Number of spans in one length of tape
p = Pull applied during measurement, N

Sign = Always negative.

5. Correction for slope (or) Correction for gradient : [C_g]

$$C_g = \frac{h^2}{2l}$$

h = difference in level blw two consecutive points, m.
l = length measured along slope blw above consecutive points, m.



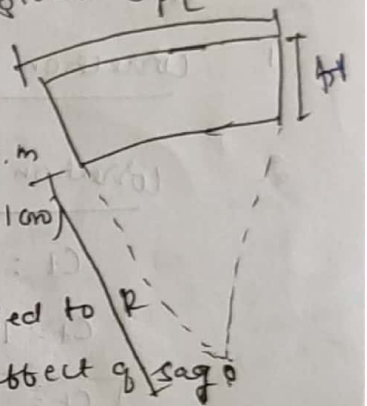
Sign: Always negative

) Reduction to Mean sea level (MSL) : [C_R]

In geodesy, all horizontal distances must be reduced to equivalent distances at MSL. The correction is given by

$$C_R = \frac{H}{R} \cdot L$$

H = elevation of Ground wrt. M.S.L. m
L = Corrected Measured distance, m
R = Radius of earth, m [6371000]



Sign: always negative.

Note: Normal tension: This the pull (or) Tension applied to the tape during measurement, which neutralises the effect of sag.

Pull correction = Sag correction

$$\left[\frac{P - P_0}{AE}\right] L' = \frac{l[w^2]}{24n^2p^2}$$

For tape length $L' = L$

$$\left[\frac{P - P_0}{AE}\right] l = \frac{lw^2}{24n^2p^2}$$

The value of P can be obtained by trial & error.

Problems on tape corrections

1. A 30m steel tape was standardised at 25°C on the flat under a pull of 60N. The length of a survey line was measured to be 1111m long with this tape at an average temperature of 36°C and a pull of 90N. The tape was supported above the ground each time it was used. Find the correct length of the survey line. The cross sectional area of the tape is 3.6 mm². Unit weight of tape material is 7.7×10^{-5} N/mm³. Young's modulus of tape material is 2.05×10^5 N/mm². Co-efficient of linear Expansion is 11.6×10^{-6} /°C

Soln Here corrections are applied per tape length and net correction per tape length is obtained. Then the corrected length of survey line is found.

$\gamma = 7.7 \times 10^{-5}$ N/mm³, $E = 2.05 \times 10^5$ N/mm², $L = 30m$, $T_0 = 25°C$, $P_0 = 60N$, $L = 1111m$, $T = 36°C$, $P = 90N$, $A = 3.6 mm^2$

1. **Correction for absolute length** $C_a = 0$ (Neither tape is too short (or) too long)

$\alpha = 11.6 \times 10^{-6}$ /°C

2. **Correction for temperature** $[C_t]$

$$C_t = \alpha [T - T_0] L'$$

$$C_t = 11.6 \times 10^{-6} [36 - 25] 30$$

$$\boxed{C_t = 0.003828 \text{ m}} \quad [+ve]$$

Hence: $\alpha = 11.6 \times 10^{-6}$ /°C

$T = 36°C$

$T_0 = 25°C$

L' = tape length = $L = 30m$.

3. **Correction for Pull** $[C_P]$

$$C_P = \frac{[P - P_0]}{AE} \times L'$$

Here $P = 90N$, $P_0 = 60N$, $A = 3.6 mm^2$

$E = 2.05 \times 10^5$ N/mm², & $L' = L = 30m$

$$C_P = \frac{(90 - 60)}{3.6 \times 2.05 \times 10^5} \times 30$$

$$\boxed{C_P = 0.001220 \text{ m}} \quad [+ve$$

$$= \frac{N}{mm^2 \times N/mm^2} \times m$$

$$= m$$

4. **Correction for Sag** (C_S)

$$C_S = \frac{l [w]^2}{24 n^2 P^2}$$

$l = L' = 30m$ W = wt of tape, N.

$n = 1$ $P = 90N$

$= \gamma \times A \times l$

$= [7.7 \times 10^{-5} \times 3.6 \times 30 \times 10^3]$

$\boxed{W = 8.316N}$

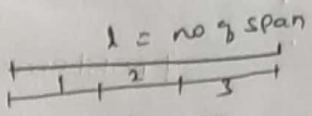
$$C_S = \frac{30 [8.316]^2}{24 \times 1^2 \times 90^2} = 0.01067 m \ [-ve]$$

$= N/mm^3 \times mm^2 \times mm$

$= N$.

$$\boxed{C_S = 0.01067m}$$

4. Correction for sag : [C_s]



$$C_s = \frac{l[w^2]}{24n^2p^2}$$

l = length of tape, m
w = weight of tape, N
n = Number of spans in one length of tape
P = Pull applied during measurement, N

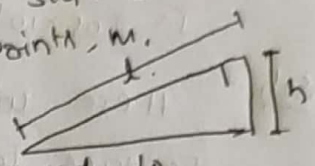
Sign = Always negative.

5. Correction for slope (or) Correction for gradient : [C_g]

$$C_g = \frac{h^2}{2l}$$

h = difference in level blw two consecutive points, m.
l = length measured along slope blw above consecutive points, m.

Sign: Always negative

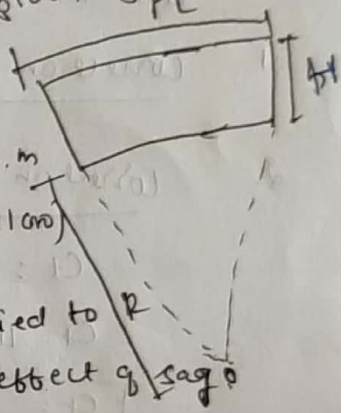


6) Reduction to Mean sea level (MSL) : [C_R]

In geodesy, all horizontal distances must be reduced to equivalent distances at MSL. The correction is given by L

$$C_R = \frac{H}{R} \cdot L$$

H = elevation of Ground wrt. M.S.L. m
L = Corrected Measured distance, m
R = Radius of earth, m [6371000]



Sign: always negative.

Note: Normal tension: This the pull (or) Tension applied to the tape during measurement, which neutralises the effect of sag.

Pull correction = Sag correction

$$\left[\frac{P - P_0}{AE}\right] L' = \frac{l[w^2]}{24n^2p^2}$$

For tape length $L' = L$

$$\left[\frac{P - P_0}{AE}\right] l = \frac{lw^2}{24n^2p^2}$$

The value of P can be obtained by trial & error.

∴ Net correction for tape length of 30m =

$= 0.003828 + 0.001220 - 0.01067$

$= -0.005622m$

$= 0.005622\,m\ (-ve)$

For 30m — correction is 0.005622 m

For 1111 m — correction is $\frac{0.005622}{30} \times 1111 = 0.2082\,m\ (-ve)$

∴ Corrected length of line $= 1111 - 0.2082$

$= 1110.7918m$

(2) A 20m steel tape was standardised on flat ground at a temperature of 20°C & under a pull of 150N. The tape was used as catenery at a temperature of 30°C and under a pull of 100N. The cross sectional area of tape is 2mm². and its total weight is 4N. The young's modulus and co-efficient of linear Expansion of steel are 2×10^5 N/mm² and 11×10^{-6}/°C. Find the correct horizontal distance.

$L^1 = 20m$ $A = 2mm^2$

$T_0 = 20°C$ $W = 4N$

$P_0 = 150N$ $E = 2.1 \times 10^5$ N/mm²

$T = 30°C$ $\alpha = 11 \times 10^{-6}$/°C

$P = 100N$

Sol

(1) $C_t = \alpha [T - T_0] L^1$ = Temperature

$= 11 \times 10^{-6} [30 - 20] 20$

$C_t = 0.0022m\ (+ve)$

2. $C_P = \left[\frac{P - P_0}{AE}\right] L^1 = \left[\frac{100 - 150}{(2 \times 2.1 \times 10^5)}\right] \times 20$ = Pull

$C_P = 0.00238m\ (-ve)$

(3) C_S = Correction for Sag

$C_S = \frac{l[w^2]}{24n^2p^2} = \frac{20(4^2)}{24 \times 1^2 \times 100^2}$

$C_S = 0.00133m\ (+ve)$ $-ve$

∴ Net correction $= +0.0022 - 0.00238 + 0.00133$

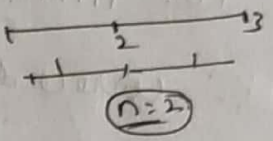
$N_c = -0.00151\,m$

Corrected length (or) distance $= 20 - 0.00151 = 19.99849$

③ A steel tape is 30m long at 18°C. when held horizontally on the ground. its sectional area is 2mm². Its weight is 12.36 N and co-efficient of Expansion is 35×10^{-7} /°C. The tape is stretched over three supports at the same level and at equal intervals. calculate the actual length. When the temperature and pull applied during measurements are 25°C and 400 N. Assume E = 1.77×10^5 N/mm²

⇝ Soln $L' = 30$ $T_0 = 18$ $T = 25°C$ $A = 2mm^2$ $\omega = 12.36\ N$

$\alpha = 35 \times 10^{-7}$ /°C $n = 2$ $P = 400$ $P_0 = 0$



1. correction for temperature $C_t = \alpha [T - T_0] L'$

$C_t = 35 \times 10^{-7} [25 - 18] 30$

$C_t = 0.000735\ m$ (+ve)

2. correction for Pull $C_p = \left[\frac{P - P_0}{AE}\right] L'$

$= \left[\frac{400 - 0}{2 \times 1.77 \times 10^5}\right] \times 30$

$C_p = 0.033898\ m$ (+ve)

3. correction for Sag $C_s = \frac{1(\omega^2)}{24 n^2 P^2}$

$C_s = \frac{30 \times 12.36^2}{24 \times 2^2 \times 400^2}$

$C_s = 0.000298\ m$ (-ve)

∴ Net correction = $C_N = 0.000735 + 0.033898 - 0.000298$

$C_N = 0.034335\ m$ (+ve)

Actual length = $L = 30 + C_N = 30 + 0.034335$

$C_N = 30.034335\ m$

Electronic Distance measurement

4. A nominal distance of 30m was set out with a steel tape from a mark on the top of one peg to a mark on the top of another peg. The tape was in catenery under a pull of 160N and at a temperature of 32°C. The top of one peg was 0.532m above the top of the other. Determine the horizontal distance b/w the marks on the two pegs.

The tape was standardised in catenery under a Pull of 130N and at a temperature of 27°C. Mass of tape = 0.022kg/m, cross sectional area = 3.15mm², co-efficient of linear Expansion = 9×10^{-7}/°C and Young's Modulus = 1.5×10^5 N/mm²

Soln

As the tape has been standardised in catenery, the true length of the tape on the flat is obtained by adding "sag correction" to the catenery length.

True length of tape = $30 + \frac{l[w^2]}{24n^2p^2}$

Here $l = 30m$,

$w = 0.022\times9.81\times30$

$W = 6.48N$

$P = 130$

$= 30 + \frac{30[6.48^2]}{24\times12\times130^2}$

$= 30 + 0.0031$

$L' = 30.0031m$

Corrections to measured length [to 30.0031 and not 30m]

1. $Ct = \alpha[T - T_0]L' = 9\times10^{-7}[32-27]\times30.0031$

$Ct = 0.000135m$ +ve

2. $Cp = \left[\frac{P-P_0}{AE}\right]L' = \left[\frac{160-130}{3.15\times1.5\times10^5}\right]30.0031$

$cp = 0.001905m$ +ve

3. $Cs = \frac{l[w^2]}{24n^2p^2} = \frac{30.0031\times6.48^2}{24\times12\times160^2}$

$Cs = 0.002051m$ (-ve)

4. $Cq = \frac{h^2}{2l} = \frac{0.532^2}{2\times30.0031} = 0.004717m$ (-ve)

Prof. & Head of Civil Engg. Dept.
B. I. E. T. Davangere - 4

20

Net correction = 0.000135 + 0.001905 − 0.002051 − 0.004717

= −0.004728 m

correct distance b/w the marks = 30.0031 − 0.004728

= 29.998372 m

⑤ A line 2 km long is measured with a tape of length 50 m, which is standardised under no pull at 15°C. The tape in section is 3mm wide and 1.25mm Thick. If one-half the line is measured at a temperature of 20°C. the other half at 26°C & The tape is stretched with a pull 215.82N, find the correct total length using the following data.

Co-efficient of linear Expansion = 12×10^{-6} /°C

Weight of $1m^3$ of tape material = 76.03 kN.

Modulus of elasticity of tape Material = 2.07×10^5 N/mm²

Sol: First half

$C_t = 12 \times 10^{-6}[20 - 15]50 = 0.003$ m (+ve)

$C_p = \frac{[215.82 - 0]}{(3 \times 1.25)(2.07 \times 10^5)} \times 50 = 0.0139014$ m (+ve)

$C_s = \frac{1w^2}{24n^2P^2} = 50$

$C_s = \frac{50 \times 14.255^2}{24 \times 12 \times 215.82^2}$

$C_s = 0.009095$ m (−ve)

Net = 0.003 + 0.0139014 − 0.009095

$N_c = 0.007613$ m

First half

$L = 12 \times 10^{-6}$

$T_M = 20$

$T_0 = 15$

$L = 50$

$P = 215.82$

$P_0 = 0$

$w = \gamma \times A \times L \times L$

$= 76.03 \times 10^3 \times 3 \times 1.25 \times 10^{-6} \times 50$

$w = 14.255$ N

$A = 3 \times 1.25$

$E = 2.07 \times 10^5$

Correction for 1000 m

True length = $\frac{0.007613}{50} \times 1000$

True length = 0.1526

True length = 1000 + 0.1526

$T_L = 1000.1526$ m

Second half :

$C_t = 12 \times 10^{-6}[26-15] \times 50 = 0.0066m$

$C_P = 0.013708m$ (+ve)

$C_S = 0.009095m$ (-ve)

Net $= 0.0066 + 0.013708 - 0.009095$

Net $= +0.011213m$

Correction for 1000m

True length $= \frac{0.011213}{50} \times 1000$

True length $= 0.22426$

TL $= 1000.22426m$

$\equiv 1000.1526 + 1000.22426$

Totoltl length $= 2000.37686m$

5) The corrected measured length of a base is 16453.15346m. If its mean elevation is 874.5m above mean sea level, find the length of the base line reduced to MSL. Assume the mean radius of earth as 6371 km.

b) Correction to reduce the distance to MSL

$C_R = \frac{h}{R} \times l$

$= \frac{874.5}{6371 \times 10^3} \times 16453.15346 = 2.25840m$ (-ve)

Length reduced to MSL $= 16453.15346 - 2.25840$

$= 16450.89506m$ ✓

Electronic Distance measurement

A total station is a combination of an "electronic theodolite" and Electronic Distance Meter (EDM). The electronic theodolite, which measures the horizontal and vertical angles, works with electronic speed and efficiency. The EDM measures the distance. A total station, when aimed at an appropriate target measures the following three parameters.

i) Horizontal angle with respect to north or any reference.
ii) Vertical angle with respect to vertical (plumb) called "Zenith angle" and
iii) Sloped distance between instrument and target.

All other data, like horizontal distance, vertical distance (REDUCED LEVELS), Coordinates (Easting and Northing) are derived from the above three fundamental parameters.

Features of Total station:

1. Angle measurement with an electronic theodolite.
2. Distance measurement with EDM. Total station uses coaxial optics in which EDM transmitter and reciever are combined with theodolite telescope. Total station measures the slope distance.
3. Control panel: Total station is acterated through its control panel. It consists of key board and multiple line Liquid Crystal Display (LCD). There are two control panels, one on each face of electronic theodolite to make them easier to use. Key board incorporates multiple multi-function keys to carry out specific tasks.
4. Power supply: Rechargeable Nickel-Cadmium batteries are used for power supply.
5. Retro-reflector: A special form of reflector known as "corner cube prism", which is mounted on a pole is used as a target.
6. On board software: A micro-processor is programmed to perform many calculations like
   i) Horizontal distances
   ii) Vertical distances (Reduced levels)
   iii) Coordinates (Northing, Easting etc).

All data recorded can be down loaded to a computer and required plotting details can be performed using a software.

Advantages of total station over conventional instruments:

i) Measurement of distances with chain and tape are eliminated.

ii) Measurement of bearings, distances (P.C), calculation of coordinates like Northing, Easting etc are eliminated.

iii) Recording staff readings using level and reduction of levels are eliminated.

iv) Reading verniers of theodolite, recording and averaging of horizontal and vertical angles are all eliminated.

v) Variation in results due to variation in atmospheric conditions like temperature, pressure etc are eliminated. This is because the values obtained with total stations are automatically corrected through sensors.

vi) Manual plotting works are eliminated.

Applications of total stations:

i) Traverse survey

ii) Topography reduction. (RLs & contour mapping)

iii) Remote object elevation

iv) Distance between remote points

v) Setting out works

vi) Transfer of data to computer.

vii) Transfer of computer file to the data recorder of total station. etc.

1.325
0.55
1.380

$(a_2)_c$
$a_2 = 1.35$

Terms:

Main Stations: These are the chain stations selected along the boundary. The line joining the main stations are called "main survey lines". These stations are denoted by △ with letters A, B. . . .

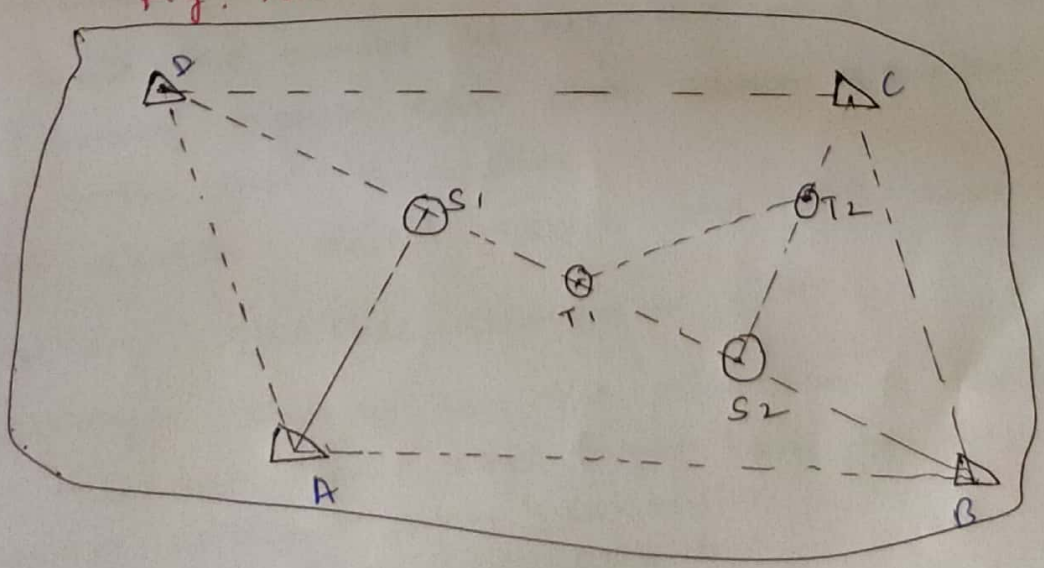
Subsidiary Stations: These are the stations selected on the main lines. The line joining the main stations and subsidiary stations is called "subsidiary line". These are denoted by ⊙ with letters S_1, S_2 . . . .

Tie Line:- It is a line connecting subsidiary stations to get the direction of the sides of the triangle. These are also used to locate the interior details. Tie stations are denoted by ⊙ with letter T_1, T_2 . . . .

Check Line: It is a line selected to check the accuracy of the ∆le. The field measurement and scaled distance are compared to check the accuracy.

Base Line: The longest line in the network of triangles is called "Base line".

Fig: Network of ∆les in chain surveying



A, B, C and D - main stations

AB, BC, CD & DA - main survey lines

S_1 & S_2 - subsidiary stations

DS_1 & BS_2 - subsidiary lines

T_1 & T_2 - Tie stations.

T_1, T_2 - Tie line (Also used as Check line)

AC - Base line.

Field Book :

The note book in which measurements are noted is known as "Field book". The field book is of size 200mm x 120mm, and opens lengthwise. which can be carried in the pocket.

There are two forms of the book

1) single line, and (2) double line.

In the field book, two red lines 15mm apart are drawn through the middle of each page. This column represents the chain line and the chainages are written init. The offsets are recorded with sketches to the left & right of this column. The reading is started from the last page and continued towards the first. The main stations are marked by △ and subsidiary (or) tie stations by ⊙ The entry on a page of field book is shown below

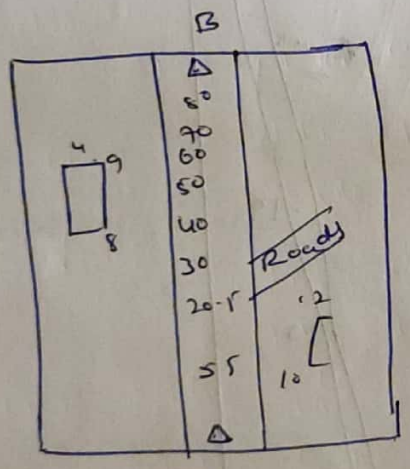


Fig. Sample of Field book page.

Precautions to be taken while entery the field book.

- All measurements should be noted as soon as they are taken
- Each chain line should be recorded on a seperate page. The recording should start from bottom of one page and each on the tape of another.
- Index sketch, object sketch and notes should be clear.
- Reference sketches should be given.
- surveyor should take the direction of chaining so that the left-hand and right hand objects can be recorded without any confusion.
- over-writing should be avoided.

* Open out a page of field book and enter the following readings

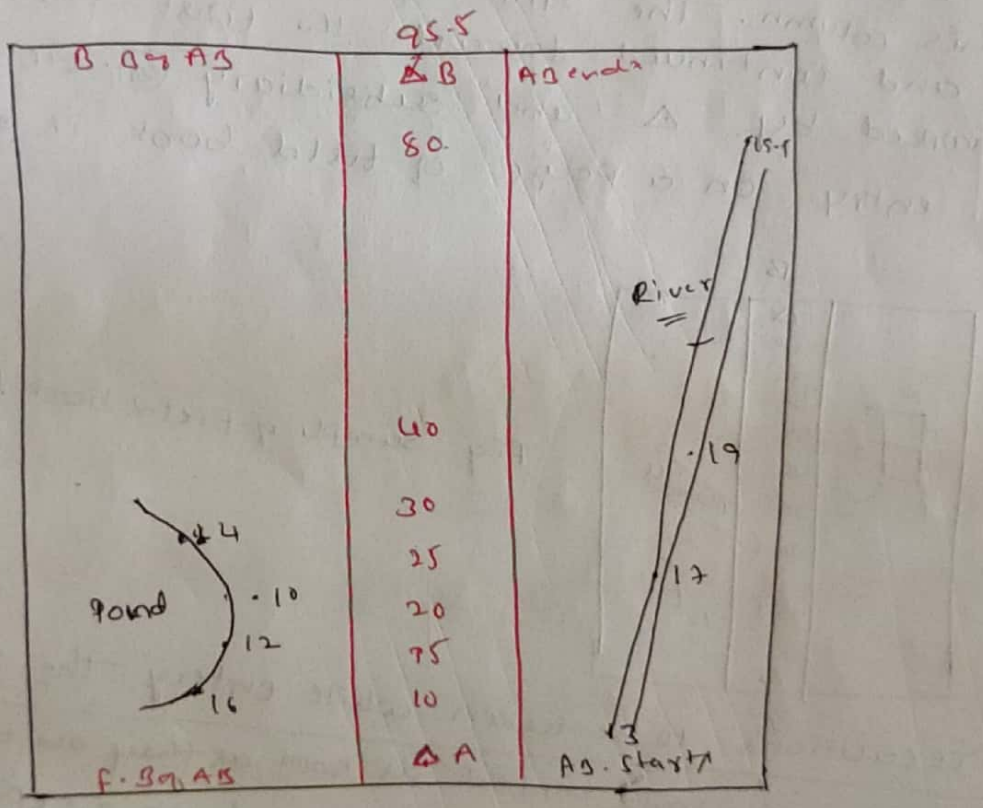
(a) Chainage of line AB is 95.5m.

(b) The offsets to the pond at the left of the chain line are as follows

Chainage	10,	15,	20,	25,	30 m
offsets	16,	12,	10,	14,	20 m

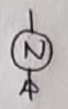
(c) The offsets to the river at the right of chain line are as follows

Chainage	5	25	40	80
offsets	13,	17	19	19.5

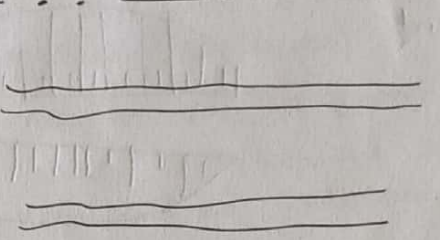


Conventional Symbols:

In a map, the objects are shown by symbols and not by names. Hence the surveyor should know the standard conventional symbols for some common objects. Following are some of standard conventional symbols.

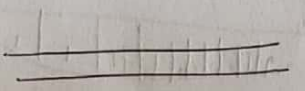
1. North line  [Black]

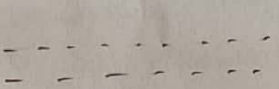
2. chain line ——— . . ——— . ——— . . ——— [Red]

3. River or stream  Blue [Prussian]

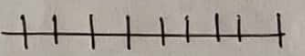
4. Pond  Blue [Prussian]

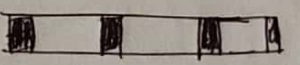
5. Road

1.  metalled Road [Burnt sienna]

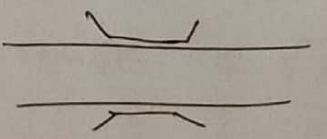
2.  unmetalled Road [— " —]

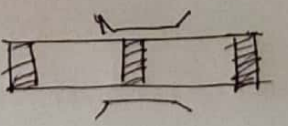
6. Railway line

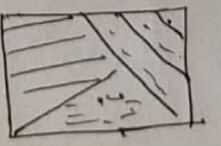
i)  Single line [Black]

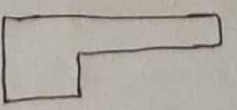
2)  Double line [Black]

7. Bridge

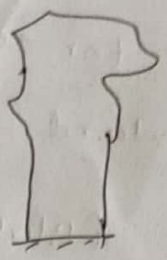
(1)  Road bridge [Black]

(2)  Railway bridge [Black]

(8) cultivated land  Green

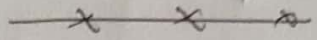
9. Building  Crimson Lake

11. Tree



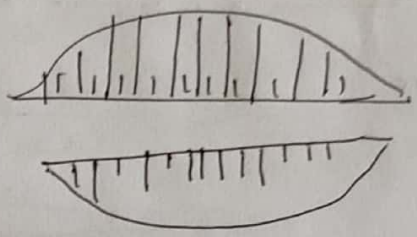
Green

12. wire Fencing



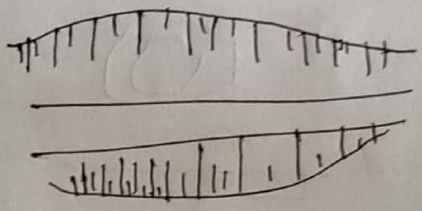
Black.

13. Embankement



Blue.

14. cutting



Black

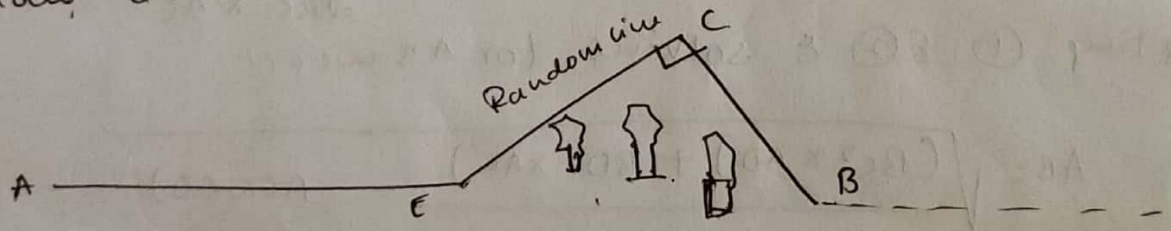
Obstacles in chaining may be grouped into three types

1. Obstacles to ranging [chaining free vision obstructed]
2. Obstacles to chaining [chaining obstructed - vision free]
3. Obstacles to both ranging and chaining.

① Obstacles to Ranging:

There are two types of such obstacles.

1. Both ends of the line may be visible from intermediate points.
   Examples: such obstacles are intervening hills (or) valleys.
   These obstacles to ranging can be overcome by resorting to reciprocal ranging.
2. Both ends of the line may not be visible from intermediate points on the line.
   Ex: Jungles.
   This obstacle to chaining can be overcome by measuring along a random line as shown in fig.



obstructed length $EB = \sqrt{EC^2 + CB^2}$

② Obstacles to chaining:

(a) When it is possible to chain round the obstacle
   Ex: a pound, etc.

(b) When it is not possible to chain round the obstacle.
   Ex: a River.

Method (1) Select two points A and B on either side. Set out equal perpendicular AC and BD. Measure C.D.
Then CD = AB [fig A]

Method 2: Set out AC perpendicular to the chain line. Measure AC and BC [Refer fig B]. The length AB is calculated from the relation

$$AB = \sqrt{BC^2 - AC^2}$$

Method: 3 By optical square (or) cross staff. find a point C which subtends 90° with A and B. Measure AC and BC. [fig C]. The length AB is calculated from the relation.

$$AB = \sqrt{AC^2 + BC^2}$$

Method: 4: Selected two points C and D to both sides of A and in the same line. Measure AC, AD, BC and BD [fig D]. Let angle BCD be equal to θ.

From Δ BCD, $BD^2 = BC^2 + CD^2 - 2BC \times CD \cos\theta$

$$\cos\theta = \frac{BC^2 + CD^2 - BD^2}{2BC \times CD} \rightarrow (1)$$

Similarly from Δ BCA, $\cos\theta = \frac{BC^2 + AC^2 - AB^2}{2BC \times AC} \rightarrow (2)$

Equating (1) & (2) & solving for AB we get

$$AB = \sqrt{\frac{(BC^2 \times AD) + BD^2 \times AC) - ACX AD)}{CD}}$$

Method: 5 Select any point E and range C in line with AE, making AE = EC, Range D in line with BE and make BE = ED. Measure CD.

Then AB = CD [Refer E]

Method: 6 Select any suitable point E and measure AE and BE. Mark C and D on AE and BE such that

$CE = \frac{AE}{n}$ & $DE = \frac{BE}{n}$ Measure CD. Then

$AB = n \cdot CD$. [fig 6]

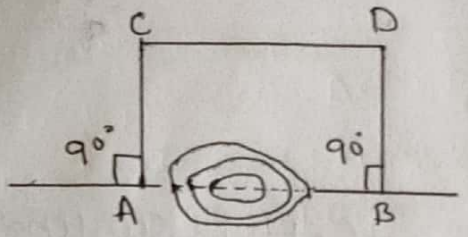


Fig (A)

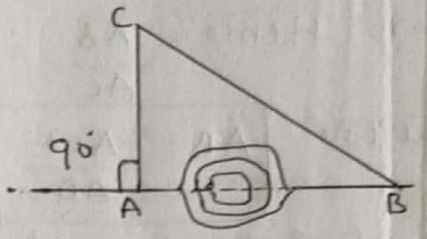


Fig [B]

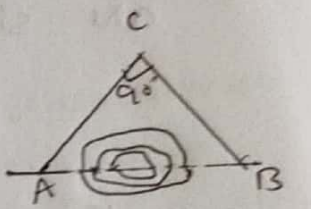


Fig [C]

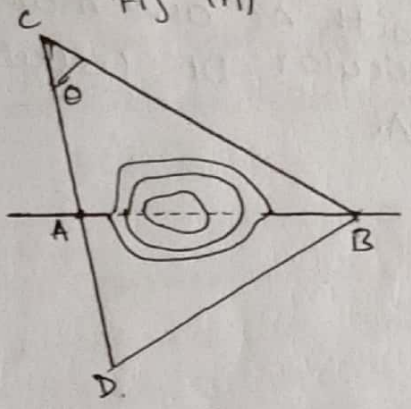


Fig [D]

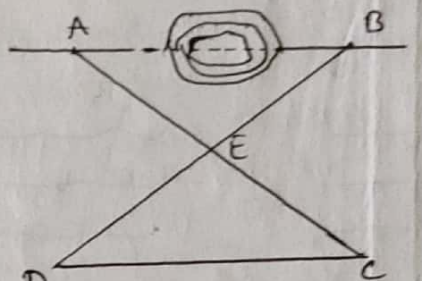


Fig [E]

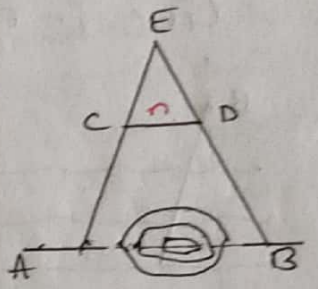


Fig [F]

Case: II.

Method (a) Select Point B on one side and A & C on the otherside. Erect AD and CE as perpendiculars to AB and range B, D and E in one line. Measure AC, AD and CE [Fig. 4]. If a line Df is drawn parallel to AB, cutting CE in F perpendicularly, then triangles ABD and FDE will be similar.

$$\frac{AB}{AD} = \frac{DF}{FE}$$

$FE = CE - CF = CE - AD$, and $Df = AC$,

From which $AB = \frac{AC \times AD}{CE - AD}$.

$\frac{AB}{AD} = \frac{AC}{CE - AD}$.

Method (b) Erect a perpendicular AC and bisect it at D. Erect perpendicular CE at C and range E in the line with BD. Measure CE [Fig 2] Then AB = CE

Method [c] Erect a perpendicular AC at A and choose any convenient point C. with help of an optical square. fix a point D on the chain line in such a way that BCD is a right angled $\triangle$. fig 3. Measure AC and AD, Triangle ABC & DAC

are similar. Hence $\frac{AB}{AC} = \frac{AC}{AD}$

Therefore $\boxed{AB = \frac{AC^2}{AD}}$

Method: 4 Fix Point C in such a way that it substend < 90° with AB. Raise D in ~~the~~ line with AC and make AD=AC, At D erect a perpendicular DE to cut the line in E [fig 4] Then AB=AE

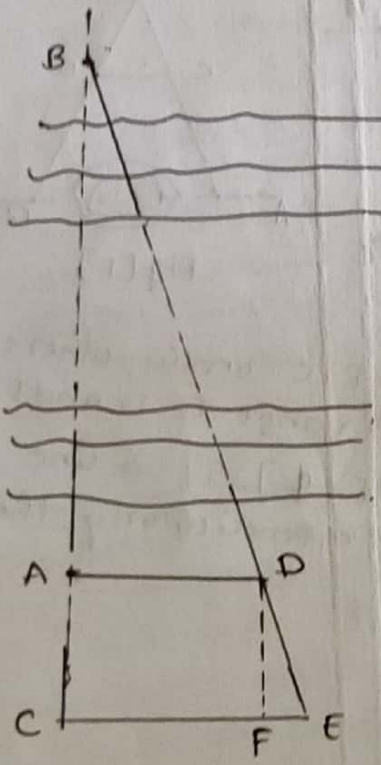


fig: 1

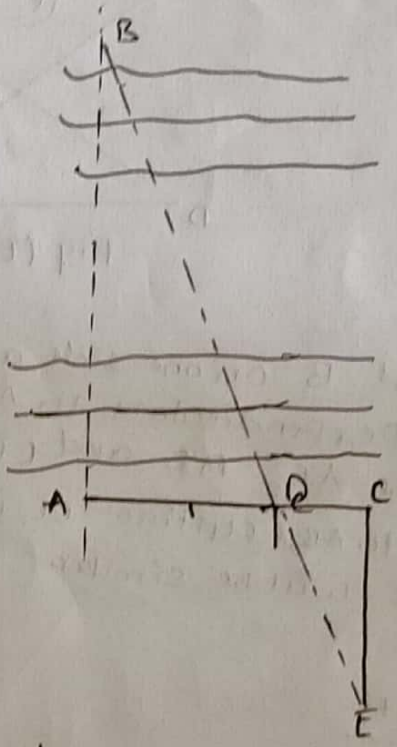


fig: 2

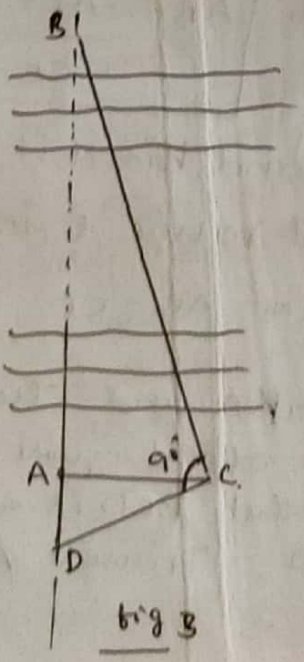


fig 3

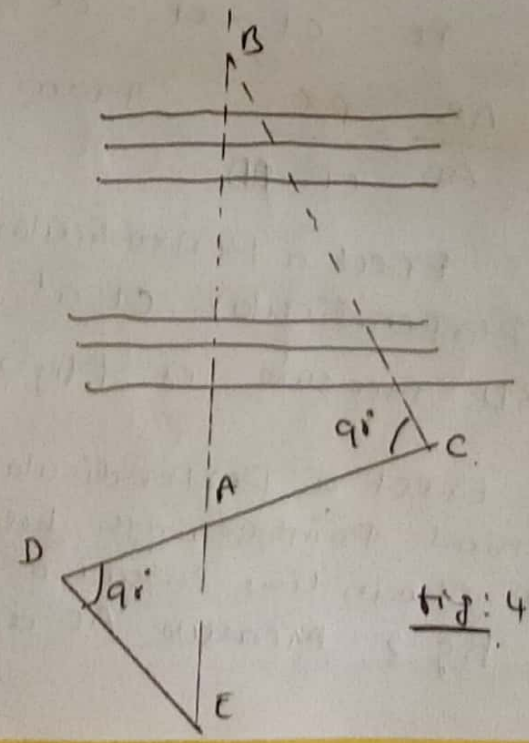


fig: 4

c) Obstacles to Both Chaining and Ranging:

Ex: Building.

Method:(a) Choose two points A and B to one side and erect perpendiculars AC and BD of equal length. Join CD & Prolong it past the obstacle. Choose two points E & F on CD erect perpendiculars EG and FH equal to that of AC (or BD). Join GH and prolong it. Measure DE. Evidently, BG = DE [Fig 1].

Method(b): Select a point A and erect a perpendicular AC of any convenient length. Select another point B on the chain line such that AB = AC. Join B and C and prolong it to any convenient point D. At D, set a right angle DE such that DE = DB. Choose another point F on DE such that DF = DC. With F as centre and AB as radius draw an arc. With E as centre, draw another arc of the same radius to cut the previous arc in G. Join GE which will be in range with the chain line. Measure CF [fig 2]

Then AG = CF.

Method (c)

Select two points A and B on the chain line and construct an equilateral triangle ABE by swinging arcs. Join AE and produce it to any point F. On AF choose any point H and construct an equilateral triangle FHK. Join F and K and produce it to D such that FD = FA. Choose a point G on FD and construct an equilateral triangle CDG. The direction CD is in range with the chain line [fig 3]. The length BC is given by

$$BC = AD - AB - CD = AF - AB - CD.$$

Method (d):

Select two points A and B on the chainline and set a line CBD at any angle. Join A and C and produce it to F such that AF = n. AC. Similarly Join A and D and produce it to G such that AG = n. AD. Join F and G and mark point E on it such that FE = n. BC. similarly produce AF and AG to H & K respectively such that AH = n'. AC and AK = n'. AD. Join H and K and mark J on it in such a way that HJ = n'. CB. Join EJ. which will be in range with chain line.

The obstructed distance BE is given by [Fig d]

$$BE = AE - AB. \quad \text{But } AE = n \cdot AB$$

$$BE = n \cdot AB - AB = (n-1)AB$$

DE = PB

PF = DC

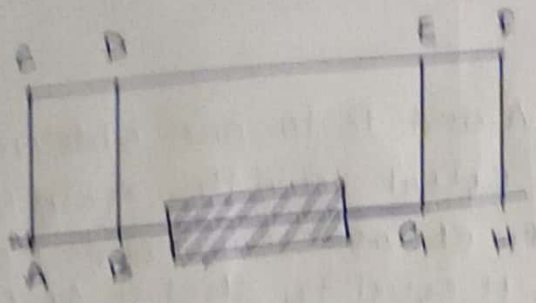


Fig (a)

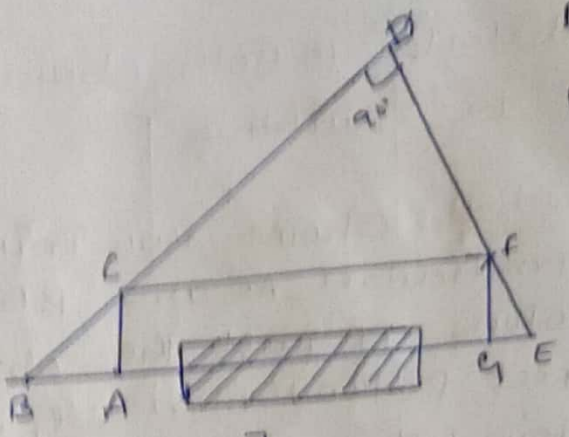


Fig (b)

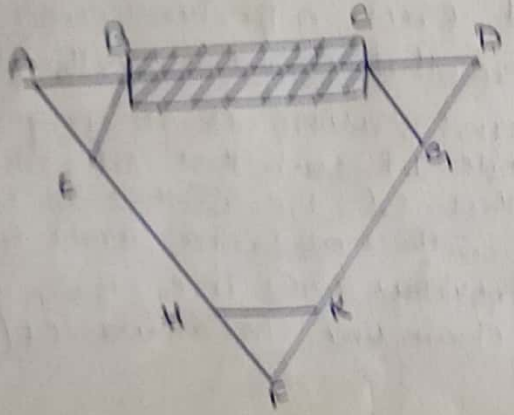


Fig (c)

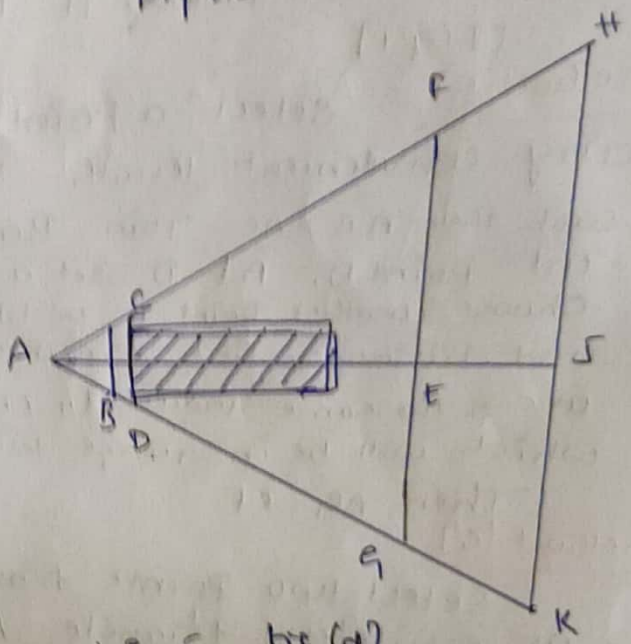
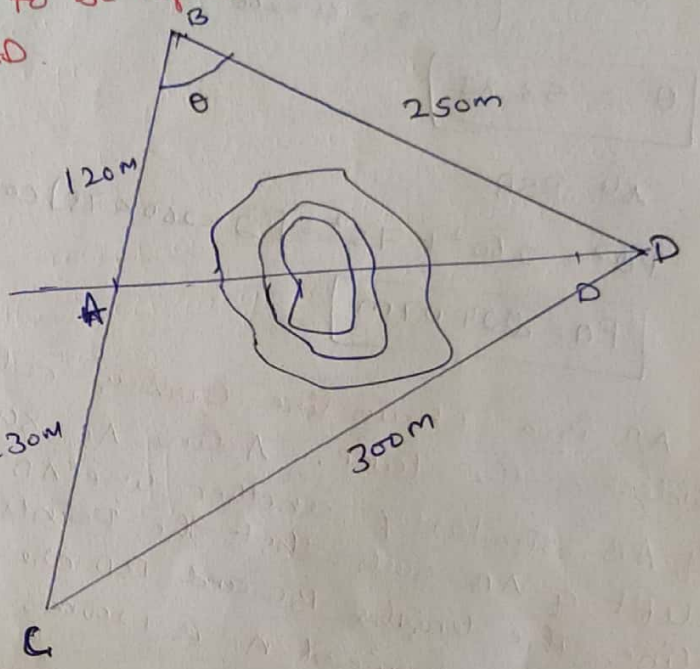


Fig (d)

Obstacles to chaining

Problems on obstacles

1. In chaining past a pond, stations A and D on the main line were taken on the opposite sides of the pond. The two lines DB and DC measuring 250m and 300m were laid down to the left and right of the line AD. The points A, B and C are on the same line. AB and AC are measured and are found to be equal to 120m and 130m. Find the length of line AD.



In ~~the~~ ΔBCD,

let $\angle DBC = \theta$.

Then from cosine rule

$$\cos\theta = \frac{BC^2 + BD^2 - CD^2}{2 \times BC \times BD}$$

$$\cos\theta = \frac{(120+130)^2 + 250^2 - 300^2}{2 \times [120+130] \times 250}$$

$$\cos\theta = 0.28 \rightarrow (1)$$

From ~~the~~ ΔABD

applying cosine rule

$$\cos\theta = \frac{AB^2 + BD^2 - AD^2}{2 \cdot AB \cdot BD} = \frac{120^2 + 250^2 - AD^2}{2 \times 120 \times 250} \rightarrow (2)$$

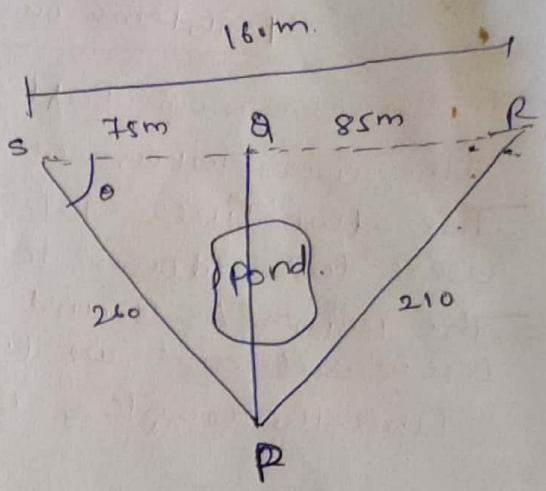
Solving eq (1) & (2) we get

$$0.28 = \frac{120^2 + 250^2 - AD^2}{2 \times 120 \times 250}$$

$$AD = 245.153m$$

(2) Two stations P and Q on the main survey line were taken on the opposite sides of a pond. On the right of PQ, a line $PR = 210m$ long was laid down and another line $PS = 260m$ long was laid down on the left of PQ. The points R, Q and S were on the same straight line. The measured lengths of RQ and QS were 85m and 75m respectively. Find the length of PQ.

B. I. E. T. Davangere - 4



△ PSR

$PR^2 = SR^2 + SP^2 - [2 \times SR \times SP]\cos\theta$

$210^2 = 160^2 + 260^2 - [2 \times 160 \times 260]\cos\theta$

$\theta = \cos^{-1}\left\{\frac{160^2 + 260^2 - 210^2}{2 \times 160 \times 260}\right\}$

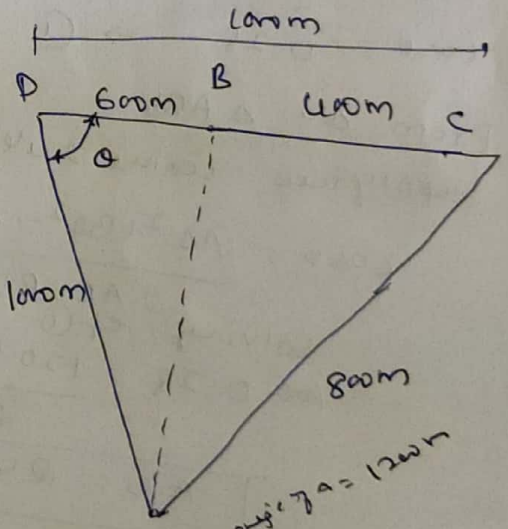
$\theta = 53.83^\circ$

△ PSQ.

$PQ^2 = 260^2 + 75^2 - [2 \times 260 \times 75]\cos 53.83$

$PQ = 224.07m$

(3) AB is a chain line crossing a lake. A and B are on the opposite sides of the lake. A line AC 800m long is ranged to the right of AB. similarly another line AD, 1000m long is ranged to the left of AB such that the points C, B and D are in the same line. The lengths BC and BD are 400m and 600m respectively. If the chainage at A is 1200m, calculate the chainage of B.



△ ADC

$AC^2 = CD^2 + AD^2 - 2CD \times AD\cos\theta$.

$800^2 = 1000^2 + 1000^2 - 2 \times 1000 \times 1000\cos\theta$.

$\theta = \cos^{-1}\left\{\frac{1000^2 + 1000^2 - 800^2}{2 \times 1000 \times 1000}\right\}$

$\theta = \cos^{-1}(0.68)$

$\theta = 47.16^\circ$

△ ADB

$AB^2 = AD^2 + DB^2 - 2AD \times DB\cos\theta$

$AB^2 = 1000^2 + 600^2 - 2 \times 1000 \times 600\cos 47.16^\circ$

$AB = 737.61m$

Chainage of A = 1200m

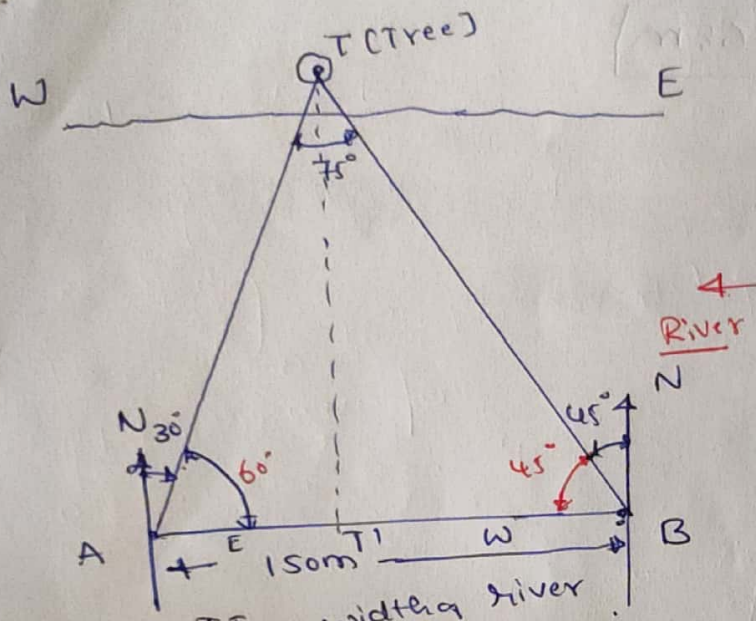
Chainage of B = chainage of A + AB

= 1200 + 737.61

Chainage of B = 1937.61m

$AC^2 = AD^2 + CD^2 - 2CD \times AD\cos\theta$

④ A and B are two points 150m apart on the nearer bank of a river which flows from East to West. The bearings of a tree on the other bank of a river as observed from A and B are N 30° E and N 45° W. Find the width of the river.



$T T_1$ = width of river

$A\hat{T}B = 180 - 60° - 45°$

$A\hat{T}B = 75°$

Sine rule to $\triangle$ ATB

$$\frac{AT}{\sin 45°} = \frac{150}{\sin 75} = \frac{BT}{\sin 60}$$

$$AT = \frac{150}{\sin 75} \times \sin 45°$$

$$AT = 109.81\ m$$

$$BT = \frac{150}{\sin 75} \times \sin 60°$$

$$BT = 134.49\ m$$

$\triangle$ ATT1

$TT_1 = AT \sin 60$

$TT_1 = 109.81 \sin 60$

$TT_1 = 95.1\ m$

$\sin 60 = \frac{TT_1}{AT}$

$\triangle$ BTT1

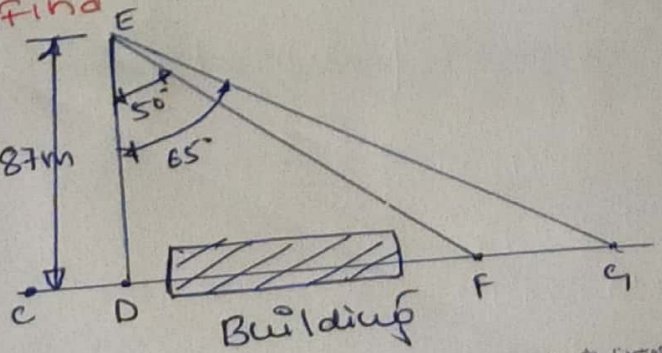
$TT_1 = BT \sin 45°$

$TT_1 = 134.49 \sin 45°$

$TT_1 = 95.1\ m$

$\sin 45 = \frac{TT_1}{BT}$

⑤ A survey line CD intersects a building. To overcome this obstacle a perpendicular DE, 87m long is set out at D. From E two lines EF and EG are set out at angles of 50° and 65° respectively with ED. Find the lengths EF and EG such that the points F and G fall on the continuation of CD. Find the obstructed distance DF.



$\triangle$ DEF $\cos 50° = \frac{87}{EF}$

$EF = \frac{87}{\cos 50}$

$EF = 135.35\ m$

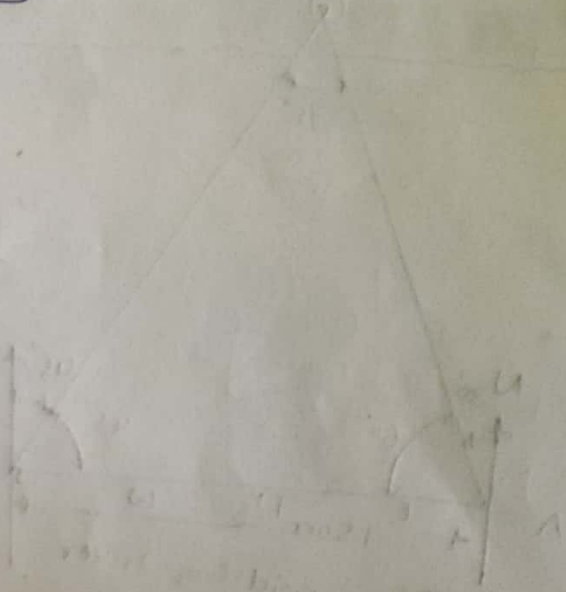
$\triangle$ DEG $\cot 65° = \frac{87}{EG}$

$EG = 205.86\ m$

Δ^{le} DEF

$$\tan 50^\circ = \frac{DF}{87}$$

$$\boxed{DF = 103.68\ m}$$



PLANE TABLE SURVEYING

This is one of the classifications of surveying in which *Plane table* is used for plotting the plan in the field. In this type of surveying, field observations and plotting of the plan are done simultaneously. It is a rough method of surveying. Hence it is used for small scale and medium scale mapping, where great accuracy is not required.

A *plane table* consists of a drawing board made of well seasoned wood. The size of the board is generally 750 mm x 600 mm. The thickness of the board is about 20 mm. The table is mounted on the *tripod* when required for plane table surveying. An aluminium ring is provided on the underside at the centre of the board. There is a threaded socket in the ring, which receives a screw passing through the head of the aluminium casting fitted to the tripod. The screw is provided with a wing nut at its lower end. The plane table can be set in any direction in the horizontal plane by means of the wing nut.

The accessories required in plane table survey are

i. Alidade
ii. Plumbing Fork
iii. Level tube and
iv. Trough compass.

An *Alidade* is a straight edge ruler having some sighting device. It is used for sighting the objects and drawing the lines. Two type of alidades namely; Plain alidade and Telescopic alidade are used. *Plain alidade* is a straight edge ruler about 450 mm long, made of metal. One of the edges (Some times both edges) is bevelled and graduated. The beveled edge is also known as 'Fiducial edge'. The alidade is provided with Eye vane at one end and Object vane at the other end. The eye vane is provided with a narrow slit and the object vane is open and carries a thin wire at the centre. The two vanes are hinged to the ruler so that they can be folded down on the ruler, when not in use. The plain alidade is not very accurate and also not suitable for plane table surveying of hilly areas. *Telescopic alidade* consists of a telescope mounted on a column that is fixed to a straight edge ruler of about 380 mm long. Telescope is supported on a horizontal axis resting on standards A vertical arc is attached to the telescope for the measurement of vertical angles. The telescope rotates in the vertical plane and clamped in any position with a clamping screw. Small movements are possible with the Tangent screw. The line of sight is aligned along the fiducial edge of the ruler. The telescope is provided with a Stadia diaphragm which helps in computations of distances. This is designed for greater accuracy and suitable long inclined sights.

A *Plumbing Fork* is a U shaped piece of metal and is used for centring the plane table over a station. The end of the upper arm is pointed and is placed on the drawing paper fixed to the plane table. A plumb bob is attached to the end of the lower arm. The point on the upper arm and the plumb bob are in the same vertical line.

A *Level tube* (or Spirit level) is used to level the plane table. The base of the level tube is flat so that it can be laid on the plane table. Levelling of the plane table is checked by placing the level tube on the drawing board in two positions at right angles to each other. When the bubble of the level tube is at the centre, the table is leveled.

A *Trough compass* is used to orient the plane table with respect to magnetic meridian. It is used for marking the North line on the drawing sheet. It consists of a long narrow rectangular box 80 to 150 mm long and 30 mm wide. It is covered with a glass. Inside the box, at its centre, there is a magnetic needle resting on the pivot. At the extremities of the compass, there are graduated scales with Zero at the centre and marking up to 5° on either side of the Zero line.

The other accessories required include *Drawing Sheet, Drawing Pins, Pencil, Eraser, scale, and Ball head pins*

SETTING UP THE PLANE TABLE

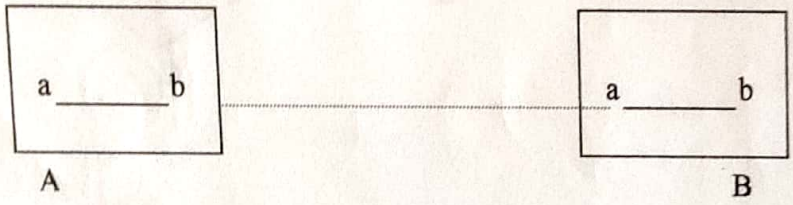
This basically consists of following three operations.

1. *Fixing the Plane Table:* The legs of the tripod should be spread and the shoes of the legs should be pushed firmly in to the ground. The top of the tripod should be at a convenient height so that the surveyor can conveniently work (drawing and sighting) at that height. The board is fixed to the tripod head and the clamp is tightened. The plane table is approximately levelled by moving the legs of the tripod. The levelling is judged by eye.
2. *Centring the Plane Table:* The centring is the process of setting up the plane table over the ground station. A plumbing fork is used for centring. The centring is complete when the pointed end of the fork is at the plotted point and the plumb bob is just above the ground station.
3. *Orientation:* Orientation is the process of aligning the plane table by rotating it in the horizontal plane such that all the plotted lines are parallel to the corresponding lines on the ground. Orientation can be done using trough compass or back sighting or by resection.

   Orientation by trough Compass: At the first plane table station, the trough compass is placed on the paper. The plane table is rotated till the needle points to the zero of the scale. A line is drawn parallel to the long edge of

the trough compass to represent the magnetic meridian. To orient the plane table at the subsequent stations, the trough compass is placed on the paper with its edge along the line representing the magnetic meridian. The plane table is then turned till the needle points to the zero of the scale. The plane table is then clamped in that position. This method of orientation is not accurate.

Orientation by back sighting: In this method the plane table is oriented by back sighting the previous station. Let us suppose that the plane table is set up at a station B on the line AB which had been plotted as ab on the paper when the plane table was set up at A (Refer Fig). The alidade is placed along the line ba and the plane table is rotated until the line of sight bisects the ranging rod at A. The plane table is clamped in that orientation



Orientation by resection: (Refer two point problem and three point problem)

METHODS OF PLANE TABLING

The following are the methods of plane tabling.

1. Radiation
2. Intersection
3. Traversing
4. Resection

The first three methods are used for locating the points or details on the paper. The last method is used for orientation and location of the plane table station.

1. Radiation Method: In the radiation method, the points are located by drawing radial lines from the plane table station. The distances of these points from the plane table station are measured and scaled off on the corresponding radial lines to locate the points. (refer figure 1)

   Procedure: Let A, B, C, D and E be the points on the ground, which are to be located on the paper by radiation method.

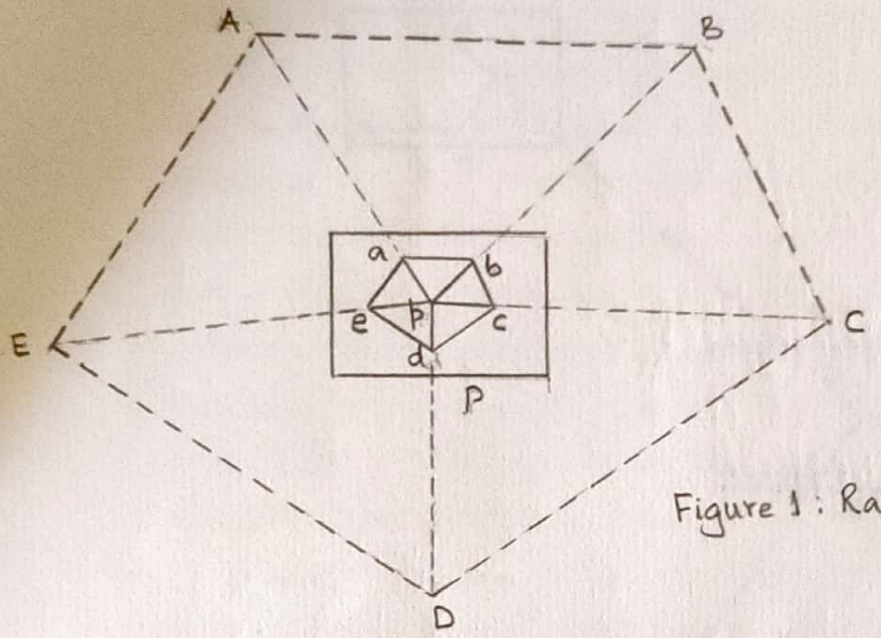


Figure 1 : Radiation

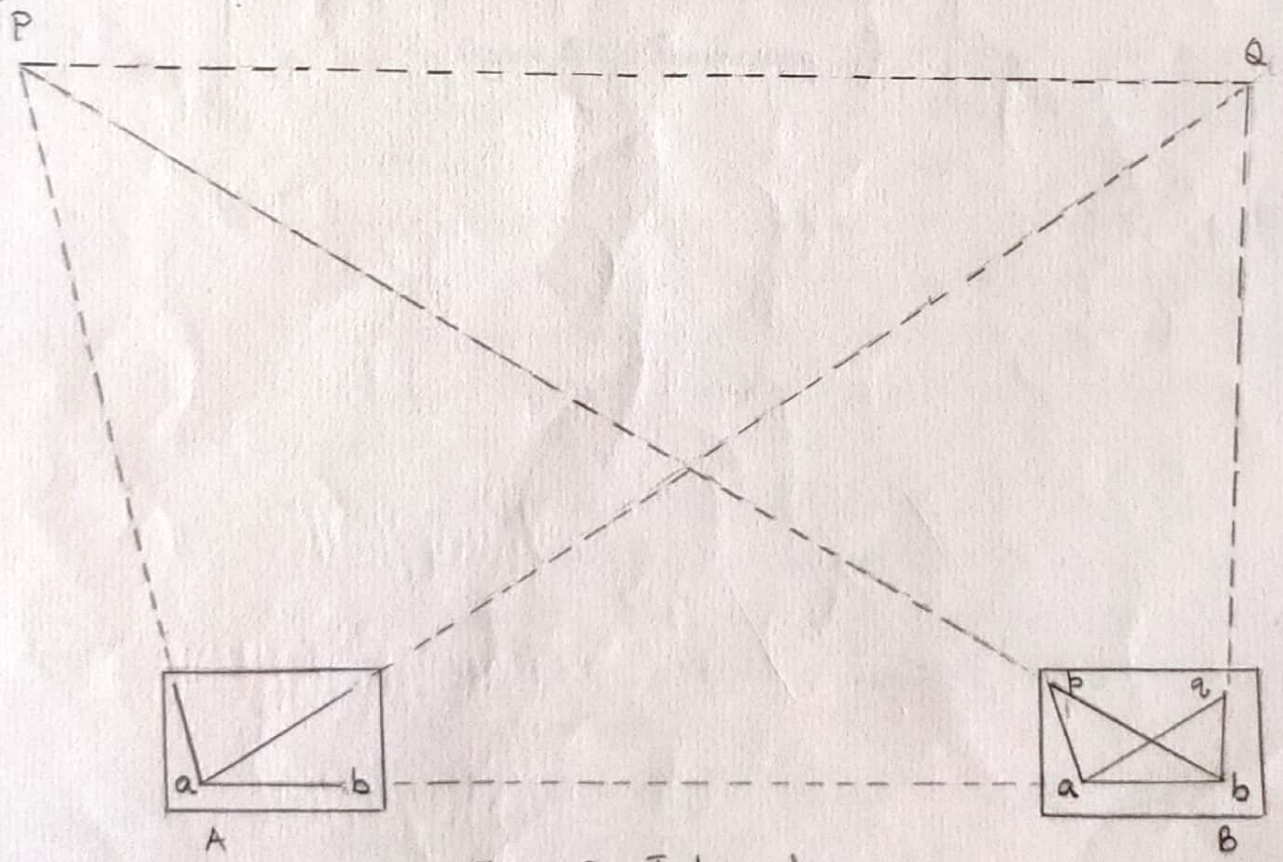


Figure 2 : Intersection.

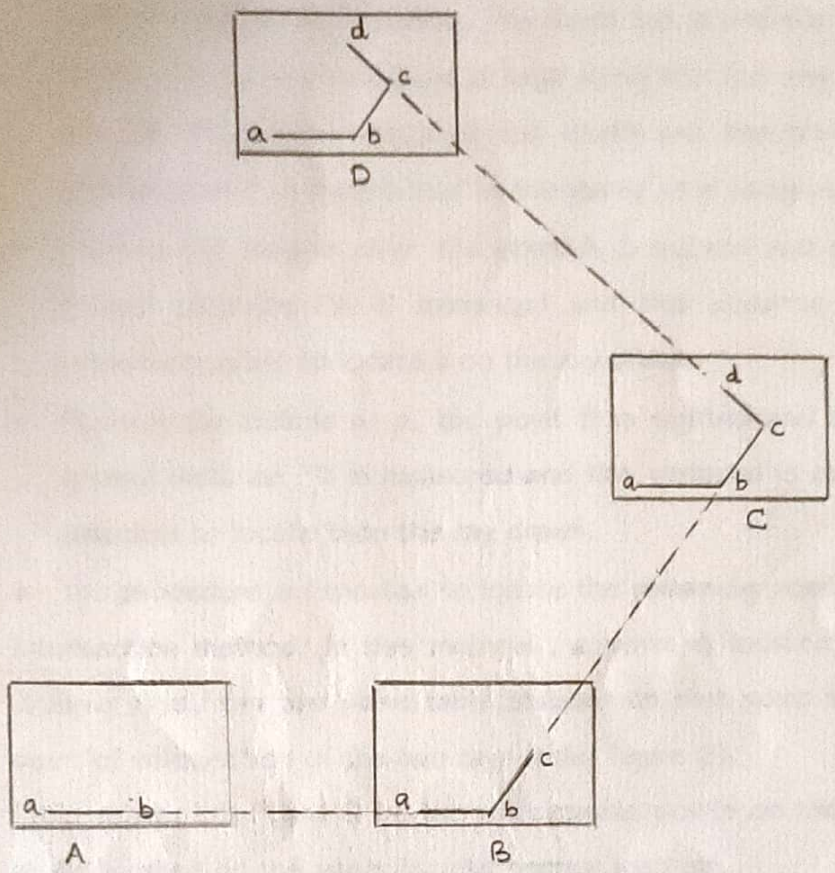


Figure 3 : Traversing

- A convenient plane table station P is selected on the ground so that all the points to be located are within measurable distance. The plane table is set over this station and levelled. The North line is drawn at the top right hand corner. The trough compass is kept along this line and the table is turned so that the needle indicates the North and the table is clamped. The ground point P is transferred to the paper as p using plumbing fork.
- Pivoting the alidade at p, the point A is sighted and a ray is drawn. The ground distance PA is measured and this distance is indicated to a convenient scale to locate a on the ray drawn.
- Pivoting the alidade at p, the point B is sighted and a ray is drawn. The ground distance PB is measured and this distance is indicated to a scale selected to locate b on the ray drawn.
- The procedure is repeated to locate the remaining points c, d and e.

2. Intersection method: In this method , a point is located on the paper by drawing rays from two plane table stations to that point and determining the point of intersection of the two rays (refer figure 2)

Proceedure: Let P and Q be the inaccessible points on the ground, which are to be located on the paper by Intersection method.

- Two instrument stations A and B are selected such that AB is approximately parallel to PQ and the triangles PAB & QAB are well conditioned.
- The plane table is set over stationA and levelled. The North line is drawn at the top right hand corner. The trough compass is kept along this line and the table is turned so that the needle indicates the North and the table is clamped. The ground point A is transferred to the paper as a using plumbing fork.
- Pivoting the alidade at a, the point P is sighted and a ray is drawn. Pivoting the alidade at a, the point Q is sighted and a ray is drawn. Pivoting the alidade at a, the ranging rod at B is sighted and a ray is drawn. The ground distance AB is measured and marked on the last ray to a convenient scale to mark b.
- The plane table is shifted to the station B and levelled. It is centred over B(b over B) using plumbing fork. It is also oriented by back sighting the ranging rod fixed at A. (For this the alidade is placed on ba and the table is

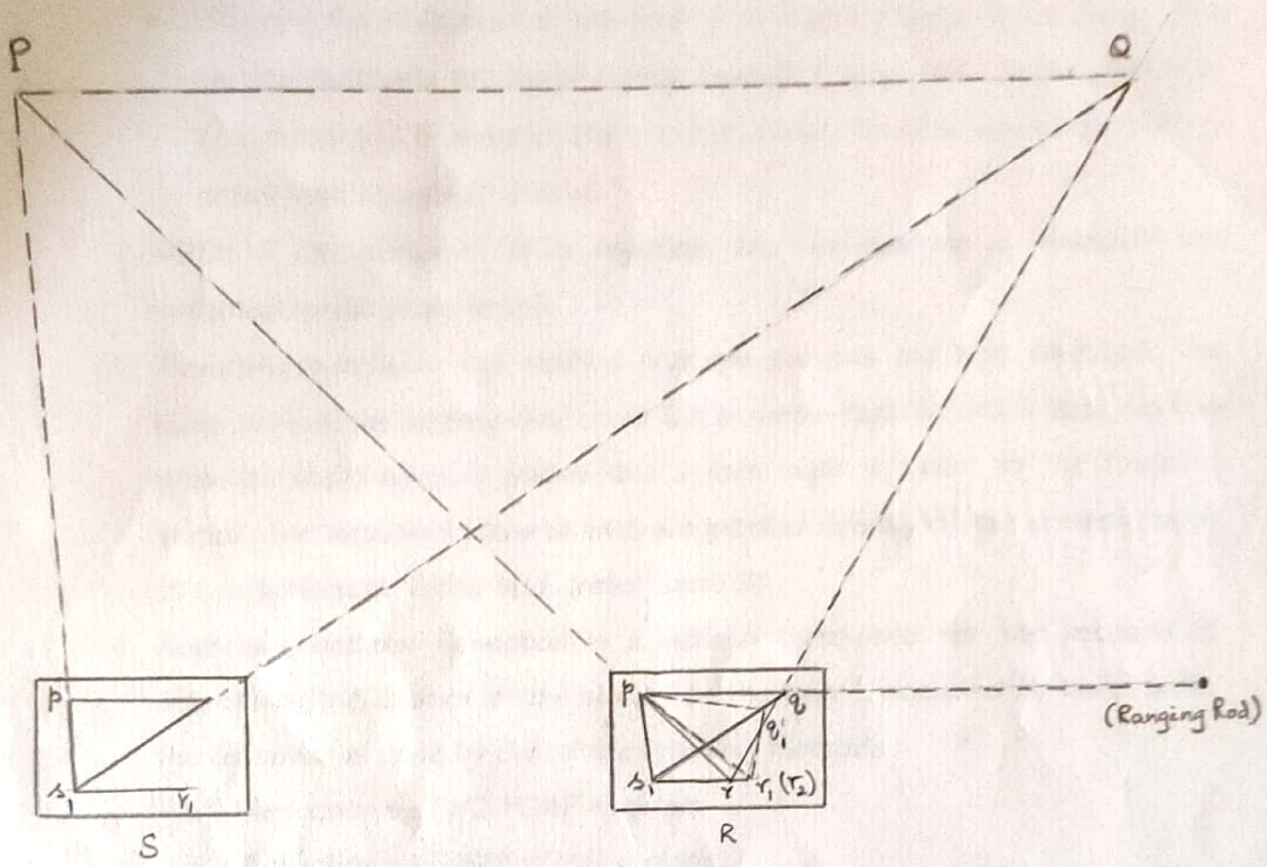


Figure 4. Two-Point Problem

turned to sight the ranging at A) For accurate work both centring and orientation must be perfect and the table must be clamped.

- Pivoting the alidade at b, the point P is sighted and a ray is drawn. This ray intersects the ray drawn from a towards P at p. Pivoting the alidade at b, the point Q is sighted and a ray is drawn. This ray intersects the ray drawn from a towards Q at q.

NOTE: *If the distance PQ is required, the distance pq is measured and multiplied by the scale factor.*

3. Traversing method: In this method traverse stations are first selected. The plane table is set successively on all the traverse stations and a back sight is taken on the preceding station and a fore sight is taken on the following station. The measured traverse lines are plotted directly on the drawing paper to a suitable scale in the field. (refer figure 3)
4. Resection method: Resection is a general term used for the process of determining the location of the station on the paper, occupied by plane table. The resection is done by one of the following methods
   i. Resection by TWO POINT Problem
   ii. Resection by THREE POINT problem

Resection by Two Point Problem:

Statement: *"Location of plane table station on the paper by means of observations to two well defined points, whose positions have been already plotted"*

Procedure: Let P and Q be the two well defined points whose positions have been already plotted as p and q. Let R be the plane table station and it is required to locate its position r on the paper (refer figure 4)

i. A suitable auxiliary point S is chosen near R so that the angles RPS and RQS are neither too acute nor too obtuse. The plane table is set at S and leveled. It is approximately oriented using the magnetic compass so that the line pq is approximately parallel to PQ. The table is clamped in this position.
ii. Pivoting the alidade at p, point P is sighted and a ray is drawn through p. Similarly pivoting the alidade at q, point Q is sighted and a ray is drawn through q to intersect the first ray at s_1. The point s_1 gives the approximate of ground station S as the orientation is approximate. The point s_1 is transferred to the ground using the plumbing fork.

iii. With the alidade pivoted at s_1, the station R is sighted and a ray is drawn. The position of r_1 is marked on this ray by estimation.

iv. The plane table is shifted to R and centred so that r_1 is above R. The table is oriented by back sighting on S.

v. Pivoting the alidade at p, point P is sighted and a ray is drawn through p to intersect s_1r_1 at r_2. The point r_2 represents the approximate position of R as orientation is approximate.

vi. With the alidade pivoted at r_2 the station Q is sighted and a ray is drawn to cut s_1q at q_1.

vii. The alidade is placed along pq_1 and a ranging rod is placed at some distance.

viii. The alidade is placed along pq and the table is turned to sight the ranging rod. The table is clamped in this position. This position of the table indicates the correct oriented position.

ix. Pivoting the alidade at p, point P is sighted and a ray is drawn through p. Similarly, pivoting the alidade at q, point Q is sighted and a ray is drawn through q to intersect the previous ray at r, which is the true position of lane table station R.

Resection by Three Point Problem:

Statement: *"Location of plane table station on the paper by means of observations to three well defined points, whose positions have been already plotted"*

Procedure: Let P Q and R be the three well defined points whose positions have been already plotted as p q and r. Let A be the plane table station and it is required to locate its position a on the paper by Bessel's graphical method. (refer figure 5)

i. The plane table set up at A and leveled.

ii. The alidade is placed along the line qp. The table is rotated to sight P and clamped. Pivoting the alidade at q, R is sighted and a ray xy is drawn.

iii. The alidade is placed along the line pq. The table is rotated to sight Q and clamped. Pivoting the alidade at p, R is sighted and a ray is drawn to cut xy at s_1.

iv. The alidade is placed along s_1r. The table is turned to sight R. The table is clamped in this position.

v. Pivoting the alidade at q, the point Q is sighted and a ray is drawn to cut s_1r at s. The point s is the plane table station S on the paper.

vi. The alidade is placed along sp. This line of sight should bisect P if the work is correct.

NOTE: If the point S lies on the circumscribing circle passing through P, Q and R, the position of s cannot be determined by three point problem. The problem becomes indeterminate, as the rays will intersect at one point irrespective of orientation of plane table.

Advantages of plane table surveying

1. Suitable for plotting small scale maps.
2. Since plotting is done in the field, field book for noting the observations is not required.
3. As the surveyor has full view of the details while plotting, the omission of any detail is avoided.
4. Comparison of actual features in the field and their plotted positions can be done to check the accuracy of the work.
5. Errors in measurements and plotting can be easily detected in the field by check lines.
6. Plane table survey can be adopted even in magnetically disturbed area where the compass survey is not possible.
7. Plane table survey is generally more rapid and less costly
8. Instruments are simple and not much skill is required.

Disadvantages of plane table surveying

1. Not very accurate.
2. Equipment is quite heavy and cumbersome. Surveyor has to carry several accessories.
3. Difficult to plot the plan to a different scale as field data are not taken
4. Plane table survey can be used only in open country where the stations can be sighted.
5. Sufficient practice is required to obtain an accurate plot.
6. Plane table survey is not possible in wet climates (Rainy) and high winds.

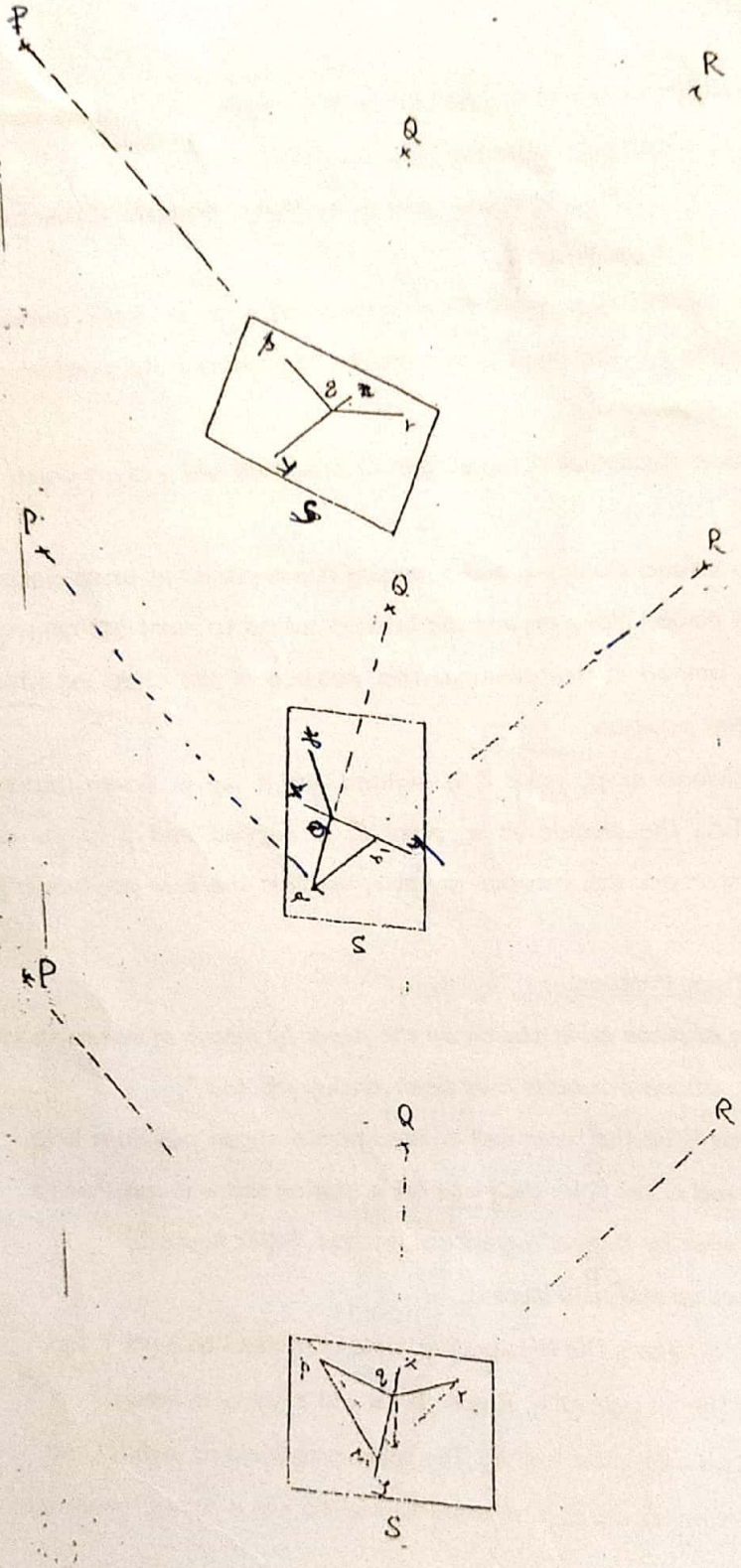


Figure 5: Three Point Problem

Errors in plane tabling:

I Instrumental Errors:- i) Surface of the drawing board, not being plane.
ii) Surface of the board, not perpendicular to vertical axis.
iii) Fiducial edge of the alidade, not being straight
iv) Eye vane and object vane, not being perpendicular to base of the alidade.

II Sighting and manipulation Errors:-
i) Non-horizontality of the board.
ii) Defective sighting
iii) Defective orientation
iv) Defective centring
v) movement of board between sights

III Errors of plotting:- Inaccurate scaling.

Strength of fix: The accuracy with which the plane table station S is fixed in three-point problem (P, Q and R) is known as "strength of fix."

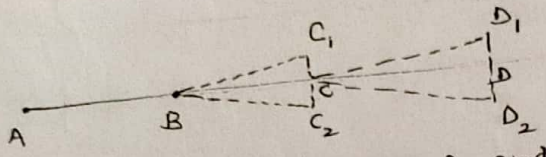
The strength of fix is "good" when
(i) the plane table station is within the great triangle PQR
(ii) the plane table station S is near the middle station than the other two.
(iii) one of the two angles subtended at the plane table station is small and the other angle is large.

The strength of fix is poor when
(i) both the angles subtended at the plane table station are small.
(ii) the plane table station is near the circumference of circumscribing circle through P, Q and R.

Method 3: When the instrument is not in adjustment: (HA not ⊥ LOS)

To prolong a straight line AB to P by establishing points C, D ...,

the following steps are adopted.



1. Theodolite is centred over B and levelled accurately w.r.t. plate level. With face left, the point A is sighted exactly and horizontal plate screws are tightened. The telescope is plunged to locate a point C_1 at some convenient distance from B. Now with face right, the point A is sighted exactly and horizontal plate screws are tightened. The telescope is plunged to locate a point C_2 at same distance of C_1 from B. (If the instrument is in adjustment, C_1 and C_2 will coincide) The point C in line with AB is the mid-point of C_1C_2.
2. The instrument is shifted to C and the above ~~process~~ step is repeated to locate point D.
3. The process is continued until P is established.

Note: The above method is known as "Double-sighting", and to be adopted when the inst^n is in poor adjustment.

CONTOURING :

A contour is an imaginary line of intersection of a level surface with the ground surface. It can also be defined as as the imaginary line joining points of equal elevations. The contours on the ground are represented by the contour lines on the map.

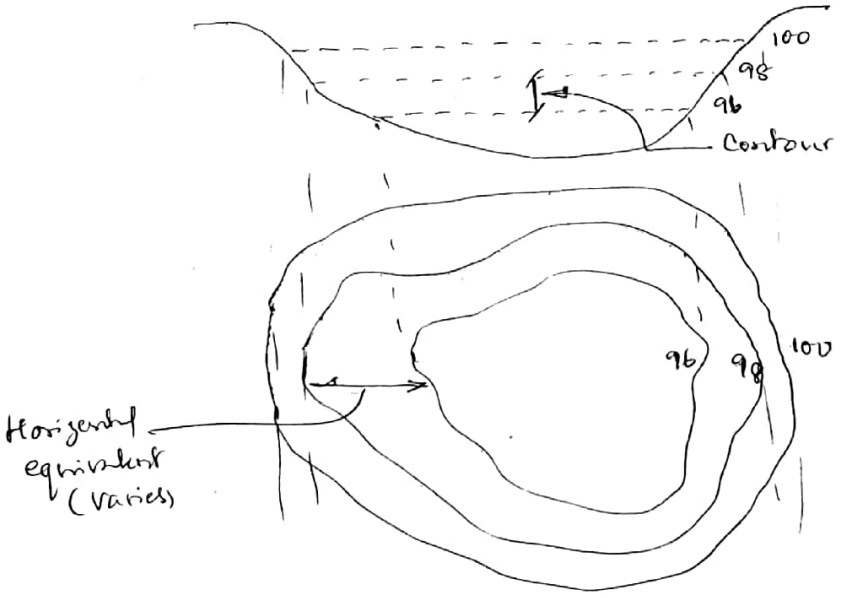
The vertical distance between any two consecutive contours is known as "Contour Interval". (Ref. fig). The contour interval depends upon

i) Nature of the ground - Contour interval for flat country are generally small. In hilly area, Contour interval is large.

ii) the scale of the map - Contour interval for small-scale map is generally large. For large scale map, contour interval is large

iii) the purpose of the survey:- Contour interval for accurate earth work calculations is small.

The horizontal distance between any two consecutive contours is known as "Horizontal equivalent".



∴ Contour Interval ≠ Hori. equivalent.

Characteristics of Contours:

1. A series of closed contours always indicate a depression or summit. The lower values being inside the loop indicates a depression (fig 1a) The higher values being inside the loop indicates a summit (fig 1b)

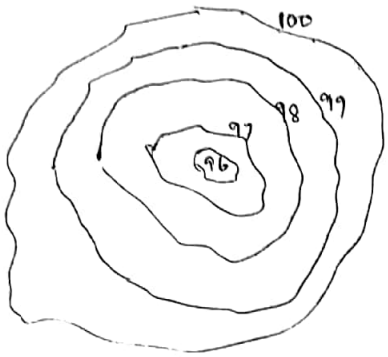


Fig 1a. Depression

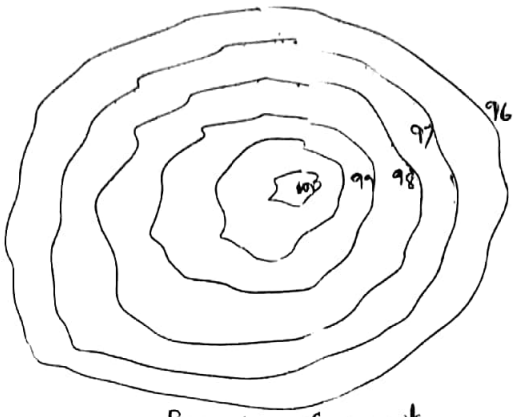


Fig 1b. Summit.

2. The nature of slope of the ground is indicated by the spacing of contours.
   i) closely spaced contours indicate steep slope (fig 2a)
   ii) Widely spaced contours indicate flat slope (fig 2b)
   iii) Uniform spaced contours indicate Uniform slope (fig 2c)

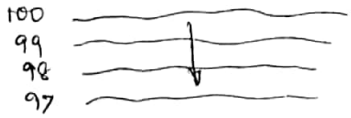


Fig 2a. Steep Slope

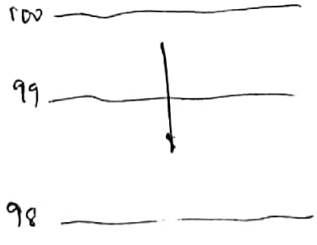


Fig 2b. Flat slope.

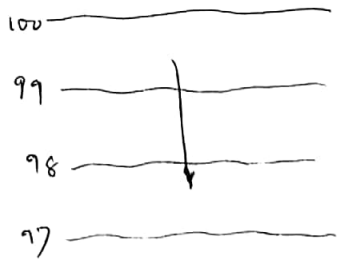


Fig 2c. Uniform slope.

3. Two Contours cannot unite or intersect, but they appear to unite in the case of vertical cliff (fig 3a) and appear to intersect in the case of overhanging cliff. (fig 3b)

Fig 3b Vertical overhanging cliff.

4. Contour lines always form a closed circuit. But these lines may be within or outside the limits of the map. (Ref. fig 4)

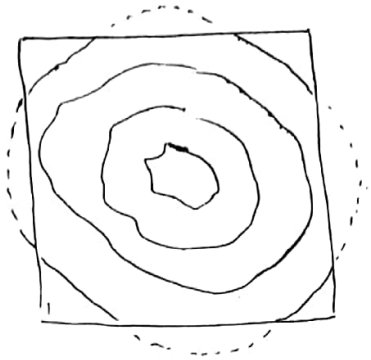


fig 4. Contour closing within & outside the map.

5. Contours deflect uphill at valley lines and downhills at ridge lines. Contour lines in U-shape cross a ridge (fig 5a) and in V/Z shape cross a Valley (fig 5b) at right angles. at right angles. The concavity in contour lines is towards higher ground. The Contour lines in V-shape cross a valley (fig 5b) at right angles The concavity in contour lines is towards the lower ground.

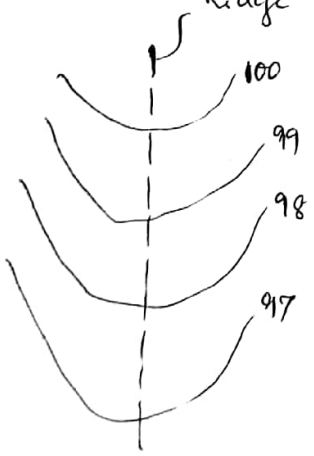
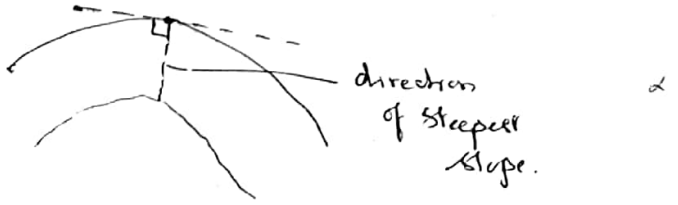


fig 5a. Ridge line.

fig 5b. Valley line.

6. The direction of the steepest slope is along the shortest distance betn the contour. Hence the direction of the steepest slope at a point on a contour is at right angles to the contour. (fig



9. Portion between two ridges & two valley lines constitute a saddle (fig 7)

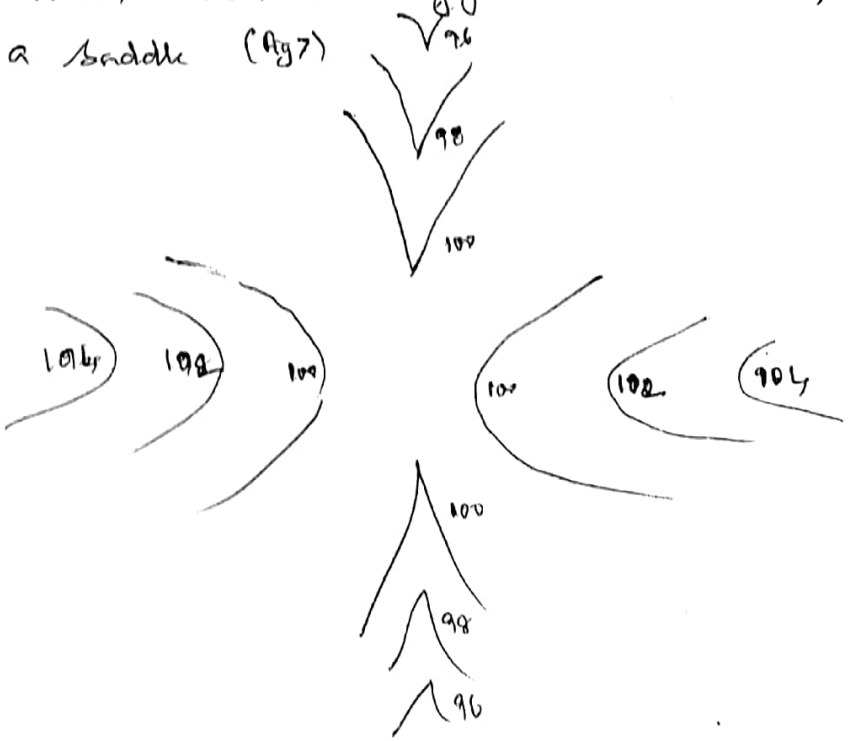


fig 7. Saddle.

Methods of Contouring:

There are two methods of contouring. They are 1) Direct method and 2) Indirect methods.

1) Direct method of contouring: In this method the contours to be plotted are actually located on the ground with a level by marking various points on each contour. These points are then surveyed and plotted on plan. This method is very slow and tedious, but most accurate and is used for contouring small areas and where great accuracy is required.

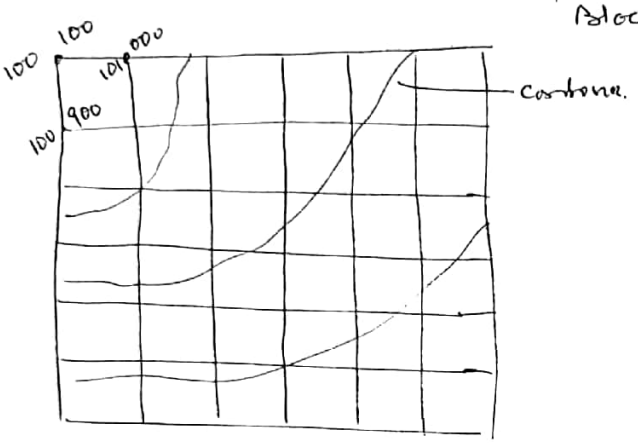
To begin with, fly levels are taken from the nearest permanent bench mark to establish a "Temporary bench mark" near the site of survey. Setting up the level in a commanding position, it is accurately levelled. The HI is determined by taking a BS on the BM. From the known elevation of the contour the staff readings to locate the contour points is obtained by deducting elevation of contour from HI. The position point giving the calculated staff readig is located searched and marked.

(If HI is 106.855 m and the contour to be located is 105 m, the staff readig required to locate the contour point is 106.855 − 105.000 = 1.855 m) The points so marked on the ground are then located by suitable methods like compass surveying, plane table surveying etc.

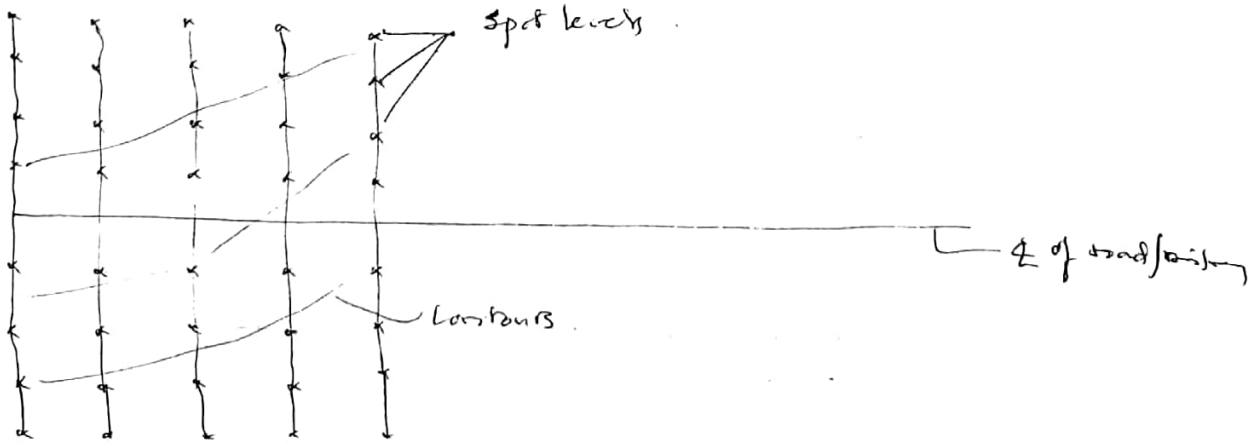
2. Indirect methods of contouring: The indirect methods are cheaper, quicker and less laborious than direct method. In these method spot levels (Reduced level of points) are taken along a series of lines covering the area to be surveyed. Their positions are then plotted on the map and the contours are then drawn by interpolation. Following are the indirect methods of locating the ground points

i) By Squares: This method is suitable, if the area is not very extensive. In this method, the area is divided into a series of squares and the corner of the squares are marked

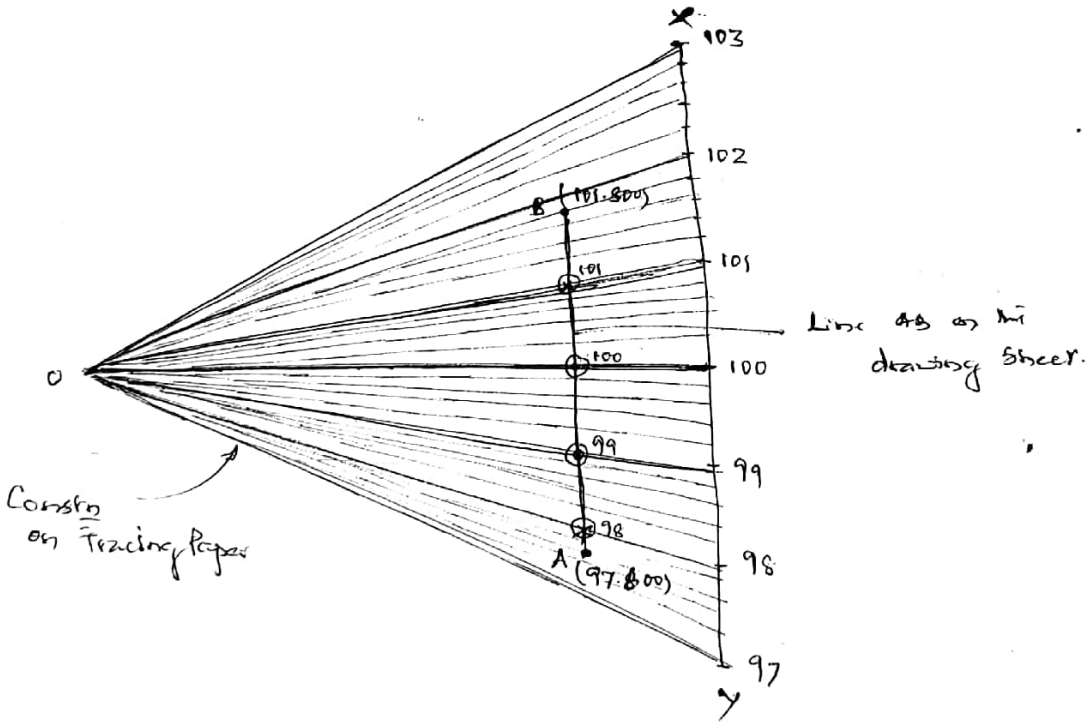
with pegs. The size of the square varies from 5 m to 20 m side, depending upon the nature of ground and contour interval. The elevations of the ground at the corner of the squares are determined with a level. The system of squares is plotted and near each corner is described & its elevation is written. The contour lines are then interpolated (Ref. fig) Some times this method is also called as "Block levelling"



ii) By cross Sections: In this method, cross sections are run transverse to the centre line of a road, railway, canal etc. The cross spacing of the cross sections depends upon the character of the terrain, the contour interval and the purpose of the survey. The elevations at the points selected on cross sections are determined. The points selected on the ground are plotted on the plan (maps), elevations are written at the points and contours are then interpolated. (Ref. fig)



3) By Graphical method: In this method, a line xy of any convenient length is taken on a tracing paper and divided into several parts, each representing any particular interval (0.2 m in fig). On a line perpendicular to xy at its mid-point, a pole O is selected. The radial lines are drawn joining the pole O and the division on the line XY. (Ref. fig) Let A and B be the two points with RLs 97.600 m and 101.800 m respectively. To locate the contour points of RLs 98, 99, 100 and 101 between the pts A & B, the tracing paper is arranged in such a way that the point A & B lie simultaneously on radial lines representing 97.600 m & 101.800 m respectively. The points at which radial lines of 98, 99, 100 & 101 intersect AB may then be pricked through.



Interpolation of contours:

The process of spacing contours proportionately between the plotted ground points established in "indirect methods" is called interpolation of contours.

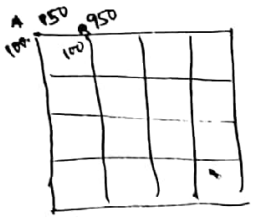
The various methods of interpolation are as follows.

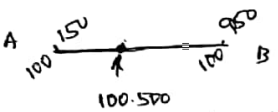
1. Estimation. 2. Arithmetic calculation & 3. Graphical method.

1. By Estimation:

This method is extremely strongly and is usually adopted when the scale of the map is small and high accuracy is not required. The positions of the contour points between the points are estimated and contours are drawn through them.

2. By A.



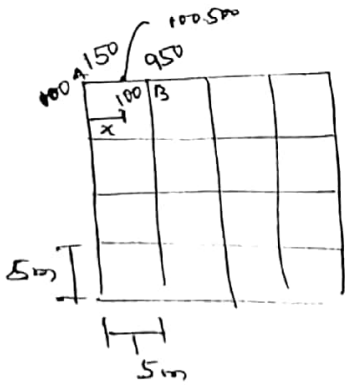


100.500

(Estimated position of 100.500 contour)

2. By Arithmetic Calculation:

This method is used when high accuracy is required and the scale of the map is of intermediate or large size. The position of required contour is calculated arithmetically and then located (Ref. following example)



In fig A with RL 100.150 m and B with RL 100.950 m are the two points at a ground dist of 5 m. Suppose If it is required to locate a point having an RL of 100.500 m between them by arithmetic calculation

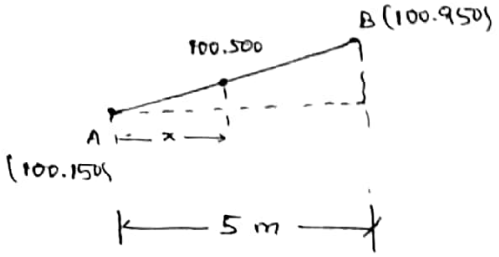
The position of 100.500 m from A is given by

$$x = \frac{(100.950 - 100.150)}{5} (100.500 - 100.150)$$

$$= \frac{5}{(100.950 - 100.150)} \times (100.500 - 100.150)$$

$$= \underline{2.1875\ m}$$

This dist is marked from A in scale. The procedure is repeated for other points



Grade Contour:

Grade Contour or Contour gradient is a line lying on the ground surface and preserving a constant inclination to the horizontal. If the inclination of such a line is given, its direction from a point may be easily located either on the map or on the ground.

Location of Contour gradient on Ground:

To locate the Contour gradient of inclination 1:100, from a point P, the level is placed at a commanding position and levelled accurately. Staff reading on point A is taken say 1.500 m. The reading on another point B say at a distance of 20 m will be $1.500 + \frac{1}{100} \times 20 = 1.700$ m. Hence to locate B, the staffman holds 20 m end of chain or tape (0 m being at A) and moves till the reading on the staff is 1.700 m. Following the same procedure, several points along a given contour gradient can be located.

Location of Contour gradient on Contour map:

Let it be required to locate a Contour gradient of inclination of 1 in 25 on a map from which the Contour interval is 2 m. from point A. The horizontal equivalent will be equal to $\frac{25}{1} \times 2 = 50$ m. Hence with A as centre and 50 m (to the same scale as that of Contour plan) an arc is drawn to cut the next contour at b. Similarly the points such as c, d, e --- B may be obtained and joined by a line. This line represents the contour gradient.

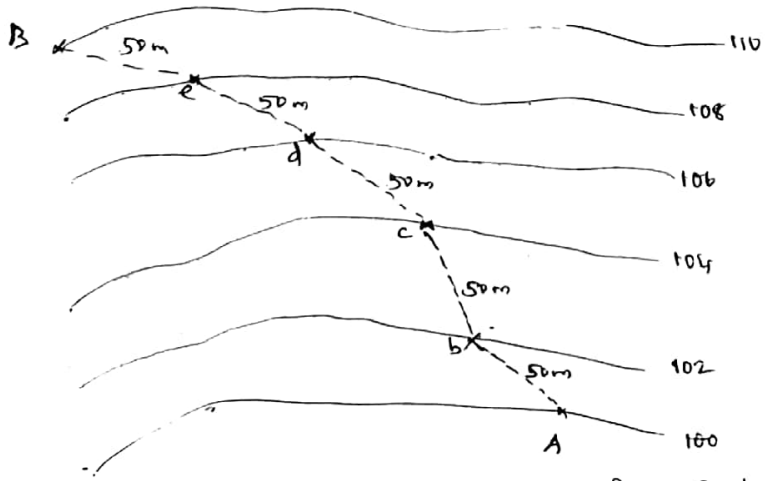


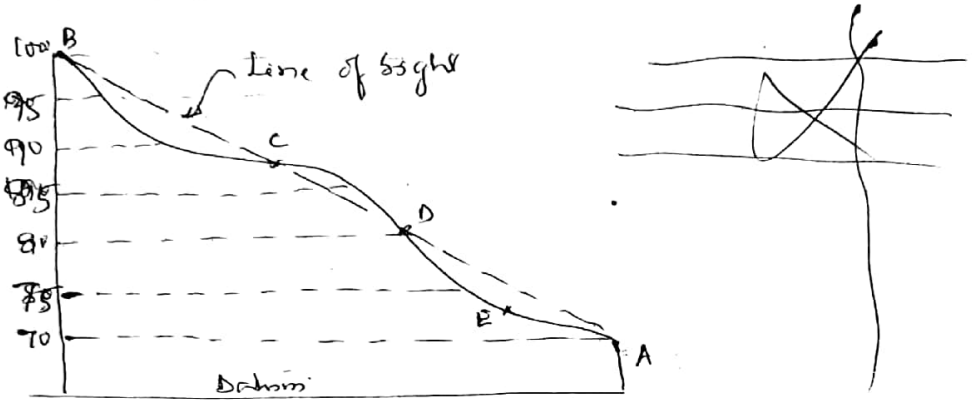
fig. Contour Gradient (A b c d e B)

Grade Contour:

Grade contour or "Contour gradient" is a line passing lying

Uses of Contours maps: (Applications)

1. Determination of intervisibility: From a contour map it can be ascertained that, whether any two points are intervisible or not. (Ref. fig 1)



The elevations of line of sight at different points are calculated (say at C, D and E). These elevations are compared with the elevation of ground at respective pts. If the elevation of line of sight is more than the elevation of ground pt, there is intervisibility. In fig A & E are intervisible, where as A & B are not intervisible.

2. Tracing of contour gradient. Location of Road: By inspecting a contour map, the most suitable route for a road, railway canal etc can be selected. By following the contour lines, steep gradients, cuttings and fillings etc. may be avoided.

3. Measurement of drainage area: A drainage area for a given point in a stream or river can be defined as the area that forms the source of all water that passes that point. The extent of drainage area on a contour map. The area is found by planimeter.

4. Determination of capacity of reservoir: A contour map is very useful in study the possible location of a dam and the volume of water confined. All the contours are the closed lines within the reservoir area

The areas $A_1, A_2 \dots A_n$ between successive contour lines can be determined by a planimeter and if h is the contour interval, the capacity of the reservoir can be estimated by the following formulae.

Trapezoidal formula:

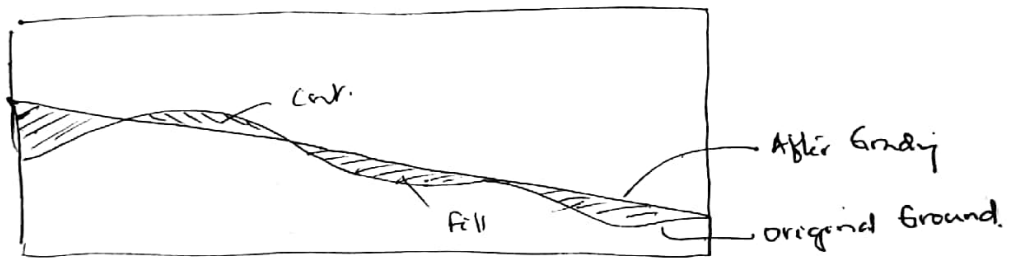
$$\text{Volume} = V = h\left[\frac{A_1 + A_n}{2} + A_2 + A_3 + \dots + A_{n-1}\right]$$

Prismoidal formula:

$$\text{Volume} = V = \frac{h}{3}\left[A_1 + A_n + 4(A_2 + A_4 + \dots A_{n-1}) + 2(A_3 + A_5 + \dots A_{n-2})\right] \quad [\text{where } n = \text{odd no}]$$

5 Drawing of sections & earthwork Calculations:

From a given contour plan, the section along any given direction can be drawn to know the general shape of the ground. This can be used for earthwork calculations for a given communication line in the direction of earthwork.



Examples:

1. The area within the contour lines at the site of a reservoir and face of the proposed dam are as follows.

Contours (m)	300	302	304	306	308	310	312	314	316
Area (m^2)	6200 (A_1)	84000 (A_2)	602400 (A_3)	905100 (A_4)	1002000 (A_5)	3075000 (A_6)	3703000 (A_7)	4505000 (A_8)	5272800 (A_9)

Taking 300m as the bottom level and 314 as the water level, find the vol of water in the reservoir.

Ans: Tr. Rule: $V = 2\left[\frac{6200 + 4505000}{2} + (84000 + \dots + 3703000)\right]$

$= 3\text{-}291\text{-}800\ m^3 = 2\,313\,420\ m^3$

Pr. Rule: $= 3\text{-}328\text{-}680\ m^3$

Module: 5. Areas and Volumes.

General Methods of Determining Areas.

The following are the general methods of calculating areas:

(1) By computations based directly on field measurements.

These includes.

(a) By dividing the area into a number of triangles.
(b) By offsets to the base line.
(c) By latitudes and Departures.
(d) By co-ordinates.
   (1) By double Meridian distance [DMD Method]
   (2) By double Parallel distance [DPD Method]

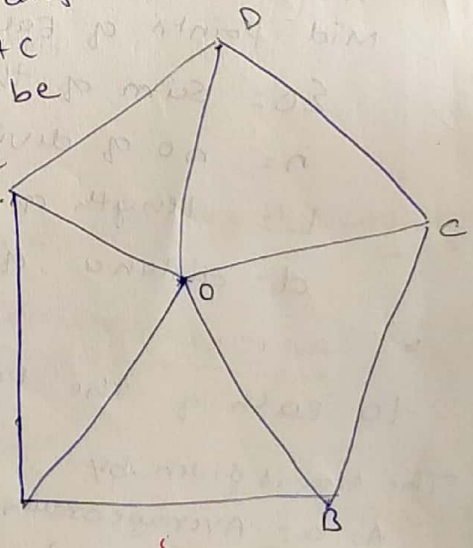
(2) By computation based on measurements scaled from a map.

(3) By Mechanical method. usually by means of a planimeter.

Areas computed by sub-division into triangles!

In this method, the area is divided into a no of triangles & the area of Each du is calculated. The total area of the tract will then be equal to the sum of areas of Individual Δles.

fig. 1 shows an area divided into several Δles. For field work, a transit may be set up at O. and the lengths & directions of each of the lines OA, OB, etc may be measured. The area of Each triangle can be computed In addition the sides AB, BC, etc can also be measured & check may be applied by calculating the area from the three known sides of a triangle. Thus if two sides and one included angle of a triangle is measured.



Area of a Δle is given by $= \frac{1}{2} ab \sin C$

When the lengths of the three sides of a Δle are measured.

Heron's formula: Area $= \sqrt{s(s-a)(s-b)(s-c)}$

s = half Perimeter $= \frac{1}{2}[a+b+c]$ [Small work]

Areas from Offsets to a base line:

(a) Offsets at Regular intervals:

This method is suitable for long narrow strips of land. The offsets are measured from the boundary to the base line (or) a survey line at Regular Intervals.

* The area can be calculated by the following methods
* Mid-ordinate Rule.
* Average-ordinate Rule.
* Trapezoidal Rule.
* Simpson's one-third Rule

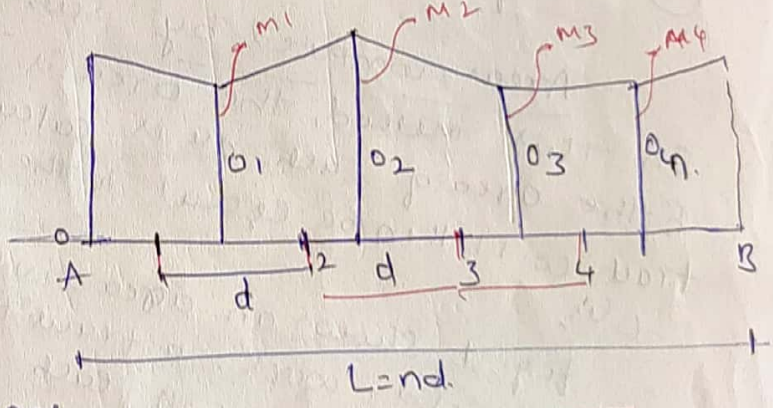
* **Mid-ordinate Rule:** This method is used with the assumption that the boundaries b/w the extremities of the ordinates (or offsets) are straight lines.
The base line divided into a number of divisions & ordinates are measured at the mid-points of each divisions

Area = A = Average ordinate × Length of base

$$= \frac{O_1+O_2+O_3+O_n}{n} L$$

$$= [O_1+O_2+O_3+\dots O_n]d$$

$$= d\Sigma O$$



where $O_1, O_2, \dots O_n$ are the ordinates at the Mid-points of each divisions

ΣO = Sum of the mid-ordinates

n = no of divisions

L = length of base line = nd.

d = distance of each division.

$A = d\Sigma m.$

(or) $A = d\Sigma O$

* **Average ordinate Rule:** The offsets are measured to each of the points of the divisions of the base line.

The Area is given by

A = Δ = Average ordinate × Length of the baseline

$$\Delta = \left[\frac{O_0+O_1+O_2\dots+O_n}{n+1}\right] L$$

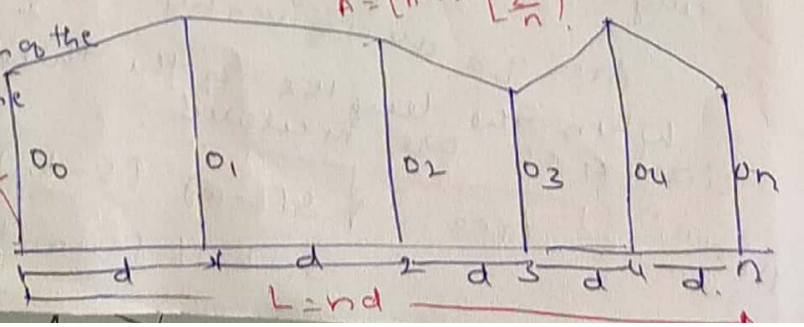
$$\Delta = \frac{L}{(n+1)}\Sigma O$$

$A = L\left[\frac{\Sigma O}{n}\right]$

$A = [n-1]d\left[\frac{\Sigma O}{n}\right]$

$A = \left[\frac{\Sigma O}{n}\right] L$

$A = (n-1)d\left[\frac{\Sigma O}{n}\right]$

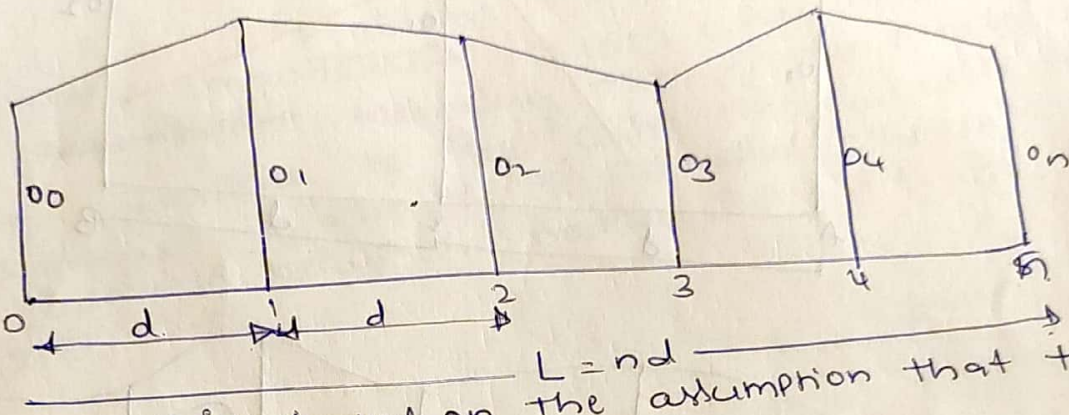


Where O_0 = ordinate at one end of the base.

O_n = ordinate at the other end of the base divided into n equal divisions.

$O_1 \ldots O_2 \ldots$ = ordinates at the end of each divisions.

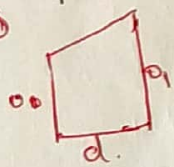
③ Trapezoidal Rule :



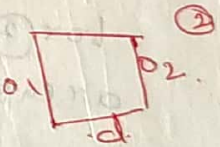
This rule is based on the assumption that the figures are trapezoids.

The rule is more accurate than the previous two rules which are approximate versions of the trapezoidal rule

The Area of a first trapezoidal is given by $\Delta_1 = \frac{O_0 + O_1}{2} \cdot d$

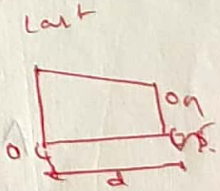


similarly. The area of the second trapezoidal is given by $\Delta_2 = \frac{O_1 + O_2}{2} \cdot d$



The Area of the last trapezoid (nth) is given by

$$\Delta_n = \frac{O_{n-1} + O_n}{2} d$$



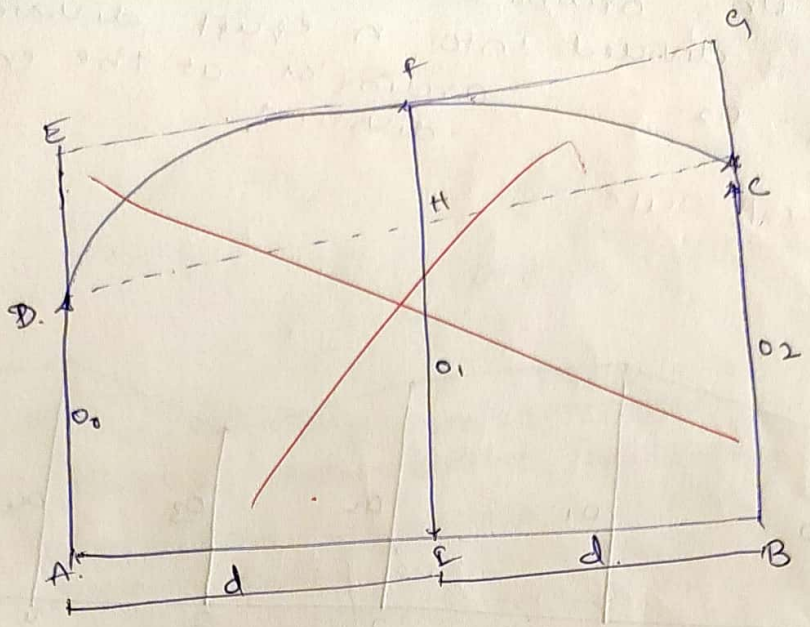
Hence the total area of the figure is given by

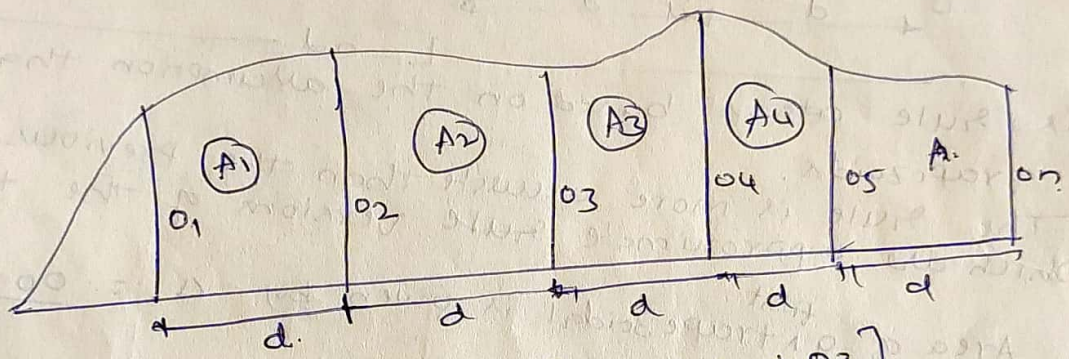
$$\Delta = \left[\frac{O_0 + O_n}{2} \cdot d + \frac{O_1 + O_2}{2} \cdot d + \ldots + O_{n-1} \right]$$

$$\Delta = \Delta_1 + \Delta_2 + \ldots \quad \Delta_n = \frac{O_0 + O_1}{2} \cdot d + \frac{O_1 + O_2}{2} \cdot d + \ldots + O_{n-1}$$

$$\boxed{\Delta = \left[\frac{O_0 + O_n}{2} + O_1 + O_2 + \ldots + O_{n-1} \right] \cdot d}$$

(4) Simpson's one Third rule: [Prism





for (2) area strips $(A_1+A_2) = \frac{d}{3}[O_1 + 4O_2 + O_3]$

$[A_3+A_4) = \frac{d}{3}[O_3 + 4O_4 + O_5]$

$A_T = A_1 + A_2 + \cdots$

$A_T = \frac{d}{3}[[O_1+O_n] + 4[O_2+O_4+O_6 \cdots + O_{n-1}] + 2[O_3+O_5+\cdots O_{n-2}]]$ (even, odd)

Note: Simpson's rule can only applied when no of offsets are in odd (or) no of strips should be even.

* Simpson's rule is more accusk for irregular shape.

UNIT : 8

AREAS AND VOLUMES:

AREA: Units: i) m^2

ii) Are (a) 1 Are = $(10)^2\ m^2$ ie 1 a = 100 m^2

iii) Hectare (ha) 1 ha = $(100)^2\ m^2$ ie 1 ha = 10 000 m^2

iv) km^2 1 km^2 = $(1000)^2\ m^2$ ie 1 km^2 = 1 000 000 m^2

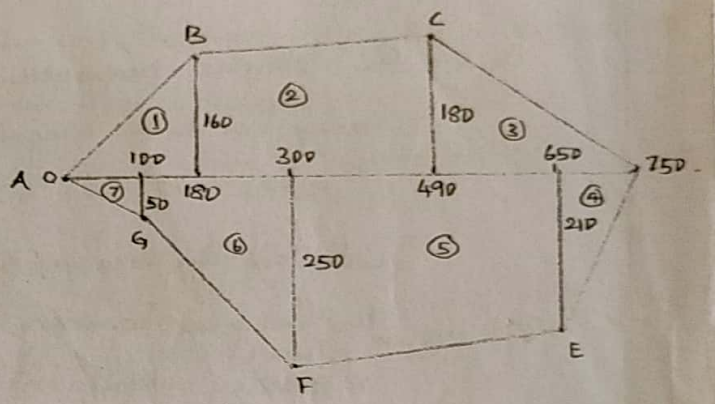
Commonly adopted Units are m^2 and hectare.

I. Area from Cross staff Survey:

Ex: Plot the following cross staff survey of a field ABCDEFG and Calculate its area.

Soln:

	750	D
	650	210 E
C 180	490	
	300	250 F
B 160	180	
	100	50 G
	0	A



$A_1 = \frac{1}{2}(180)(160)$ = 14 400

$A_2 = \frac{1}{2}(490-180)(160+180)$ = 52 700

$A_3 = \frac{1}{2}(750-490)(180)$ = 23 400

$A_4 = \frac{1}{2}\times(750-650)(210)$ = 10 500

$A_5 = \frac{1}{2}\times(650-300)(210+250)$ = 80 500

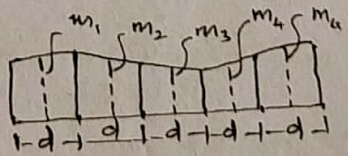
$A_6 = \frac{1}{2}\times(300-100)(250+50)$ = 30 000

$A_7 = \frac{1}{2}\times(100)(50)$ = 2 500

∴ Total Area = A = 214 000 m^2 Ans.

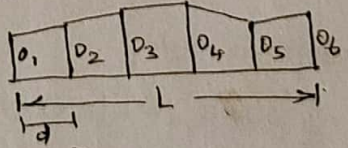
II Area from Ordinates:

1. Mid-ordinate rule:



$A = d \Sigma m$

2. Average ordinate rule:



$A = L\left[\frac{\Sigma O}{n}\right] = (n-1)d\left[\frac{\Sigma O}{n}\right]$

n = no of ordinates

3. Trapezoidal rule: $A = d\left[\left(\frac{O_1+O_n}{2}\right) + O_2+O_3+\cdots O_{n-1}\right]$

4. Simpson's One-third rule (Parabolic rule) $A = \frac{d}{3}\left[(O_1+O_n) + 4(O_2+O_4+\cdots O_{n-1}) + 2(O_3+O_5+\cdots O_{n-2})\right]$

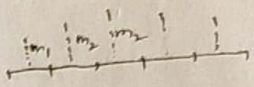
(Accurate)

> or < T.R

* Applicable only when there are odd no of ordinates (or even no of segments)

Ex. 1. Offsets were taken from a chain line to a curved boundary. The chain line was 50 m long and was divided into 5 sections. The offsets taken to the middle of each section at 5 m, 15 m, 25 m, 35 m and 45 m were found to be 5.4 m, 6.8 m, 8.4 m, 7.5 m and 7.2 m respectively. Calculate the area between the chain line and the boundary using the mid-ordinate rule.

Fig.



Soln: $A = d(\Sigma O)$ – mid ordinate rule.

$= 10[5.4 + 6.8 + 8.4 + 7.5 + 7.2] = \underline{353\ m^2}$ Ans

Ex. 2: The following perpendicular offsets were taken at 10 m intervals from a survey line to an irregular boundary line.

3.82, 4.37, 6.82, 5.26, 7.59, 8.90, 9.52, 8.42 and 6.43 m.

Calculate the area in Sq.m enclosed between the survey line, the irregular boundary line and the first and last offsets by

i) average ordinate rule

ii) Trapezoidal rule and

iii) Simpson's rule.

Soln: No. of observation of ordinates $= n = 9$ No. of segments $= 8$ $\therefore L = 8 \times 10 = 80$ m

i) Average ordinate rule:

$$A = L\left[\frac{\Sigma O}{n}\right] = 80\left[\frac{3.82 + 4.37 + 6.82 + 5.26 + 7.59 + 8.90 + 9.52 + 8.42 + 6.43}{9}\right]$$

$= 80[6.792] = \underline{543.38\ m^2}$ Ans.

ii) Trapezoidal rule:

$$A = d\left[\frac{O_1 + O_n}{2} + O_2 + O_3 + \cdots O_{n-1}\right]$$

$$= 10\left[\left(\frac{3.82 + 6.43}{2}\right) + (4.37 + 6.82 + 5.26 + 7.59 + 8.90 + 9.52 + 8.42)\right]$$

$= \underline{560.05\ m^2}$ Ans.

iii) Simpson's rule:

$$A = \frac{d}{3}\left[(O_1 + O_n) + 4(O_2 + O_4 + \cdots O_{n-1}) + 2(O_3 + O_5 + \cdots O_{n-2})\right]$$

$$= \frac{10}{3}\left[(3.82 + 6.43) + 4(4.37 + 5.26 + 8.90 + 8.42) + 2(6.82 + 7.59 + 9.52)\right]$$

$$= \frac{10}{3}\left[(10.25) + (107.8) + 2(47.86)\right]$$

$= \underline{553.03\ 8\ m^2}$ Ans.

3) A series of offsets were taken from a chain line to a curved boundary line at intervals of 15 m in the following order.

0, 2.65, 3.80, 3.75, 4.65, 3.60, 4.95 and 5.85 m.

Compute the area between the chain line, the curved boundary and the end offsets by Simpson's rule.

Soln: Here the Simpson's rule cannot be applied directly since the number of ordinates is "EVEN". However the area between the first and seventh offsets may be calculated by Simpson's rule and the area enclosed between the seven and last offsets may be found by the trapezoidal rule.

Thus $A = A_1$ (Area by Simpson's rule) $+ A_2$ (Area by trapezoidal rule)

Here $A_1 = \frac{d}{3}\left[(O_1+O_7) + 4(O_2+O_4+O_6) + 2(O_3+O_5)\right]$

$= \frac{15}{3}\left[(0+4.95) + 4(2.65+3.75+3.6) + 2(3.80+4.65)\right] = 309.25 \text{ m}^2$

& $A_2 = \frac{d}{2}\left[O_7+O_8\right] = 15\left[\frac{4.95+5.85}{2}\right] = 81.00 \text{ m}^2$

$\therefore A = 309.25 + 81.00 = \underline{390.25 \text{ m}^2}$ Ans.

4) The following perpendicular offsets were taken from a chain line to a an irregular boundary.

Chainage, m.	0	10	25	42	60	75
	1	2	3	4	5	
offset m	15.5	26.2	31.8	25.6	29	31.5

Calculate the area between the chain line, the boundary and the end offsets.

Soln: In this case, the area of each trapezoid is calculated seperately and then added together to get the total area.

Area of first trapezoid: $A_1 = d\left[\frac{O_1+O_2}{2}\right] = (10-0)\left\{\frac{15.5+26.2}{2}\right\} = 208.5 \text{ m}^2$

$A_2 = (25-10)\left\{\frac{26.2+31.8}{2}\right\} = 435.0 \text{ m}^2$

$A_3 = (42-25)\left\{\frac{31.8+25.6}{2}\right\} = 487.9 \text{ m}^2$

$A_4 = (60-42)\left\{\frac{25.6+29}{2}\right\} = 491.4 \text{ m}^2$

$A_5 = (75-60)\left\{\frac{29+31.5}{2}\right\} = 453.8 \text{ m}^2$

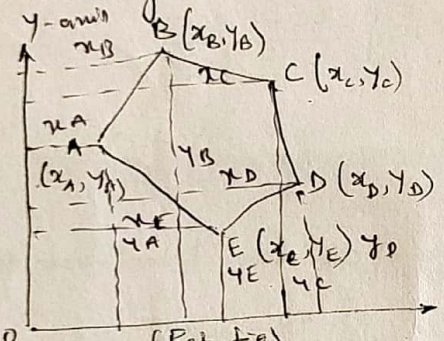
Total area $= A = 2076.6 \text{ m}^2$ Ans

Comparison of rules:

1. The results obtained by using Simpson's rule are more accurate and hence used, where great accuracy is required.
2. The results obtained using Simpson's rule are "greater or less" than those obtained by using the trapezoidal rule depending on the curve of the boundary is concave or convex towards the base line.
3. For the application of the Trapezoidal and Simpson's rules, the interval between the successive ordinates must be uniform, throughout the length of the base line.

III Area from Co-ordinates:

"Co-ordinates of Points of a closed traverse with respect to a common Origin is are known as "Independent co-ordinates".



Double Area = $(\Sigma P - \Sigma Q)$

Area = $\frac{1}{2}(\Sigma P - \Sigma Q)$

The co-ordinates of stations A, B, C, D & E are; $(x_A, y_A), (x_B, y_B), (x_C, y_C), (x_D, y_D)$ & (x_E, y_E)

To find the area (Ref. fig), the co-ordinates are arranged in the form of determinants as follows

$$\left\{ \begin{matrix} y_A & y_B & y_C & y_D & y_E & y_A \\ x_A & x_B & x_C & x_D & x_E & x_A \end{matrix} \right\}$$

Then $A = \frac{1}{2}(\Sigma P - \Sigma Q)$

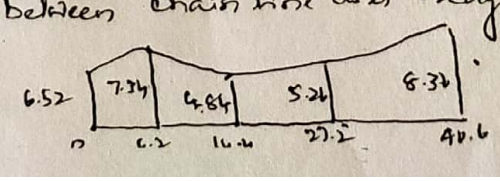
Where $\Sigma P = (y_A x_B + y_B x_C + y_C x_D + y_D x_E + y_E x_A)$

and $\Sigma Q = (x_A y_B + x_B y_C + x_C y_D + x_D y_E + x_E y_A)$

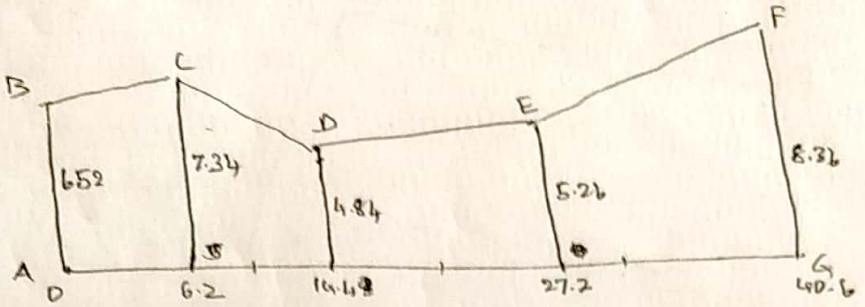
Ex: 1) The following perpendicular offsets were taken from a chain line to a hedge (boundary)

Chainage, m.	0	6.2	16.4	27.2	40.6
offset, m.	6.52	7.34	4.84	5.26	8.36

Calculate the enclosed area between chain line and hedge by the co-ordinate method.



Soln:



Taking A (Point corresponding to 0-chainage) as origin, the coordinates of points are as follows

Point.	A	B	C	D	E	F	G	A
x	0	0	6.2	14.4	27.2	40.6	40.6	0
y	0	6.52	7.34	4.84	5.26	8.36	0	0

$$\Sigma P = [(0\times6.52)+(0\times7.34)+(6.2\times4.84)+(14.4\times5.26)+(27.2\times8.36)+(40.6\times0)+(40.6\times0)]$$

$$= 333.144\ m^2$$

$$\Sigma Q = [(0\times0)+(6.52\times6.2)+(7.34\times14.4)+(4.84\times27.2)+(5.26\times40.6)+(8.36\times40.6)+(0\times0)]$$

$$= 838.74 \checkmark$$

$$\therefore A = \frac{1}{2}[\Sigma P - \Sigma Q] = \frac{1}{2}[333.144 - 838.74] = -248.8\ m^2$$

Area.

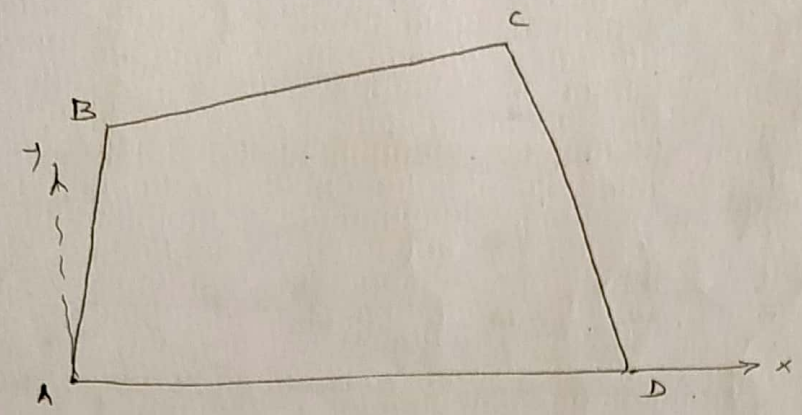
2) The following table gives the corrected latitudes and departures (in metres) of the sides of a closed traverse ABCD. Compute its area by coordinates method.

Side.	Latitude N	Latitude S	Departure E	Departure W
AB	+108	-	+4	-
BC	+15	-	+249	-
CD	-	-123	+4	-
DA	0	-	-	-257

A	0	0
B	4	108
C	253	123
D	257	0
A	0	0

6

Soln:



Coordinates of

	x	y		
A →	0	0		
B →	4	108	(0+4)	(0+108)
C →	253	123	(4+249)	(108+15)
D →	257	0	(253+4)	(123-123)

Arranging these coordinates in determinant form.

	A	B	C	D	A
x	0	4	253	257	0
y	0	108	123	0	0

$\Sigma P = [(0\times108)+(4\times123)+(253\times0)+(257\times0)] = 492\ m^2$

$\Sigma Q = [(0\times4)+(108\times253)+(123\times257)+(0\times0)] = 58935\ m^2$

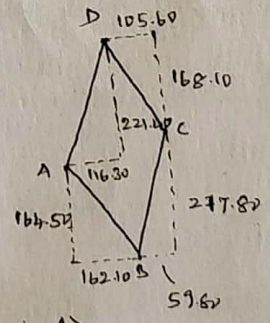
$\therefore A = \frac{1}{2}[\Sigma P - \Sigma Q] = \frac{1}{2}[492 - 58935] = -29221.5\ m^2$

$\therefore A = 29221.5$ Sq. m. (Ans)

Ex-3) The latitudes and Departures of the lines of a closed traverse ABCDA are given. Compute the area by independent co-ordinate method.

Line	Latitude	Departure
AB	-164.50	+162.10
BC	+217.80	+59.80
CD	+168.10	-105.60
DA	-221.40	-116.30

Soln:



Co-ordinates. (Assumed Origin is A)

Point.	A	B	C	D	A
y	0	-164.50	+53.3	+221.4	0
x	0	+162.10	+221.90	+116.30	0

$\Sigma P = [(0\times162.10)+(-164.50\times221.90)+(53.3\times116.30)+(221.4\times0)] = -30303.76\ m^2$

$= [0 - 36502.6 + 6198.9 + 0]$

$\Sigma Q = [(0\times-164.50)+(162.10\times53.3)+(221.90\times221.4)+(116.30\times0)] = 57768.59\ m^2$

$\therefore A = |(57768.59) - (30303.76)| = 44$

b) The latitudes and departures of the lines of a closed traverse PQRS are given below. Compute the area by coordinates method.

Line.	Latitude.	Departure.
PQ.	+ 225.28	227.26
QR	− 139.61	417.26
RS	− 336.90	−196.47
SP	+ 251.23	−448.05

Solution:

	P	Q	R	S	P
Latitude (Y)	0	225.28	85.67	−251.23	0
Departure (x)	0	227.26	644.52	448.05	0

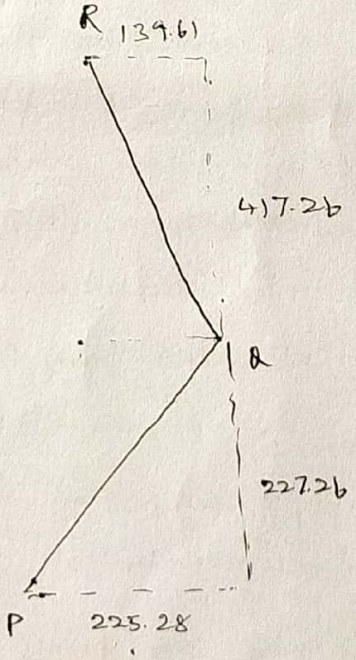
$\Sigma P = [0 + (225.28 \times 644.52) + (85.67 \times 448.05) + 0] =$ 183 582 ~~183 580.4~~ m^2

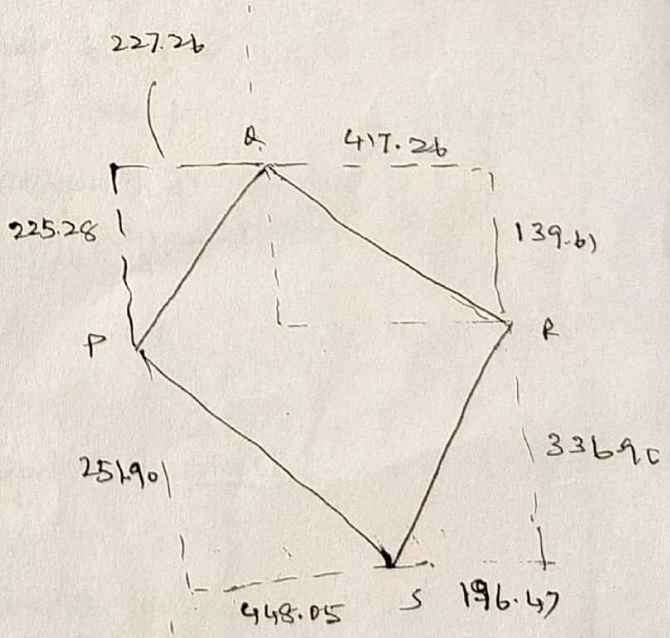
$\Sigma Q = [0 + (227.26 \times 85.67) + (644.52 \times -251.23) + 0] = -142,453.4\ m^2$

$\therefore A = \frac{1}{2}[\Sigma P - \Sigma Q] = \frac{1}{2}[183\,580.4 - (-142,453.4)] =$ ~~162 991.9~~ m^2 163 017.5 m^2

16.30175 ha

= ~~16.2991 hectares~~





VOLUME:

If $A_1, A_2, A_3 \ldots A_n$ are areas of cross sections at an interval of 'd' then the volume may be calculated either by "Trapezoidal rule" or "prismoidal rule"

i) Trapezoidal rule:

$$V = d\left[\frac{A_1+A_n}{2} + A_2+A_3+\ldots A_{n-1}\right]$$

ii) Prismoidal rule (Also known as Simpson's rule for volume)

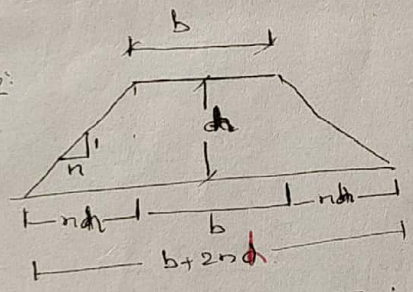
$$V = \frac{d}{3}\left[(A_1+A_n) + 4(A_2+A_4+\ldots A_{n-1}) + 2(A_3+A_5+\ldots A_{n-2})\right]$$

Note: Method is applicable when there odd no of areas. If n is an even, the prismoidal formula is applied upto (n-1) areas and trapezoidal rule is applied for betn (n-1) and n areas.

Examples:

(1) A railway embankment is 10 m wide with side slopes 1.5 : 1. Assuming the ground to be level in a direction transverse to the centre line, calculate the volume contained in a length of 120 m, the centre heights at 20 m intervals are 2.2, 3.7, 3.8, 4.0, 3.8, 2.8, and 2.5 m.

Soln:



Area $= \frac{1}{2}(b+b+2nd)\cdot d = (b+nd)d$.

$= (b+nh)h$

Given. $b = 10$ m; $n = 1.5$; $d = 2.2, 3.7, 3.8, 4.0, 3.8, 2.8$ and 2.5 m.

∴ Area of c/s at 0 m chainage $= A_1 = (10+1.5\times2.2)\times2.2 = 29.26\ m^2$

" " 20 m chainage $= A_2 = (10+1.5\times3.7)\times3.7 = 57.54\ m^2$

40 m $= A_3 = (10+1.5\times3.8)\times3.8 = 59.66\ m^2$

60 m $= A_4 = (10+1.5\times4.0)\times4.0 = 64.00\ m^2$

80 m $= A_5 = (10+1.5\times3.8)\times3.8 = 59.66\ m^2$

100 m $= A_6 = (10+1.5\times2.8)\times2.8 = 39.76\ m^2$

120 m $= A_7 = (10+1.5\times2.5)\times2.5 = 34.38\ m^2$

Volume i) By Trapezoidal formula:

$$V = d\left[\frac{(A_1+A_7)}{2} + (A_2+A_3+\ldots A_6)\right] = 20\left[\frac{29.26+34.38}{2} + (57.54+59.66+64.00+59.66+39.76)\right]$$

$= 6248.8\ m^3$ Ans.

ii) By Prismoidal formula:

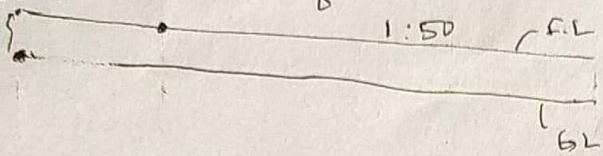
$$V = \frac{d}{3}\left[(A_1+A_7) + 4(A_2+A_4+A_6) + 2(A_3+A_5)\right]$$

$= \frac{20}{3}\left[(29.26+34.38) + 4(57.54+64.00+39.76) + 2(59.66+59.66)\right]$

2) A road embankment is 30 m wide at the top with side slopes 2:1 The ground levels at 100 m intervals along a line AB are as follows.

170.30 (A), 169.10, 168.50, 168.10, 166.50 (B). The formation level at A is 178.70 m with a uniform falling gradient of 1 in 50 from A to B. Determine the Volume of earthwork. Assume ground to be level in cross section

Soln:



Scale: 1:5000 (H)
1:1000 (V)

Datum: 166.000

Ch		FL	Depth of fill, (h)
A	0	170.30	178.40 8.1
	100	169.10	176.40 7.3
	200	168.50	174.40 5.9
	300	168.10	172.40 4.3
B	400	166.50	170.40 3.9

Gradient
1:50
for 100m - 2m fall

$A_1 = (30 + 2 \times 8.1)\, 8.1 = 374.22\ m^2$

$A_2 = (30 + 2 \times 7.3)\, 7.3 = 325.58\ m^2$

$A_3 = (30 + 2 \times 5.9)\, 5.9 = 246.62\ m^2$

$A_4 = (30 + 2 \times 4.3)\, 4.3 = 165.98\ m^2$

$A_5 = (30 + 2 \times 3.9)\, 3.9 = 147.42\ m^2$

Volume: i) Trapezoidal rule: $A = 100\left[\frac{374.22 + 147.42}{2} + 325.58 + 246.62 + 165.98\right]$

$= 99\,900\ m^3 = 9.9900$ ha Ans.

ii) Prismoidal rule: $A = \frac{100}{3}\left[374.22 + 147.42 + 4(325.58 + 165.98) + 2(246.62)\right]$

$= 99370.7\ m^3 = 9.93707$ ha Ans

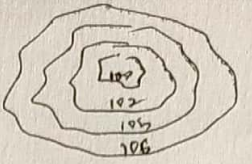
3) (Home work) A railway embankment 400 m long is 12 m wide at the formation level and has the side slope 2 to 1. The ground levels at every 100 m along the centre line are as follows

Distance, m	0	100	200	300	400
RL, m	204.8	206.2	207.5	207.2	208.3

The formation level at zero chainage is 207 m and the embankment has a rising gradient of 1 in 100. The ground is level across the centre line. Calculate the Volume of earthwork.

Ans i) Trapezoidal : 14137 m^3

Capacity of reservoirs:



Fig

The capacity of reservoir is calculated from contour plans. As shown in fig, a no of contour lines are available at a selected contour interval. The area lying in a contour line is measured using a planimeter. Such measured areas are then used to calculate the volume of water that can be stored in the reservoir using either trapezoidal or prismoidal formula.

Ex.: Find the capacity of a reservoir from the contour data given below. The plan is drawn to a scale of 1:4000 (1cm = 40m)

	1	2	3	4	5	6	7	8	9	10	11
Contour, m	260	258	256	254	252	250	248	246	244	242	240
Area, cm^2	400	367.5	327.5	310	277.5	243.75	205	177.5	147.5	115	0

Soln: Contour interval = d = 2 m.

Area $A_1 = 400 \times 40^2 = 640\,000\ m^2$; $A_2 = 367.5 \times 40^2 = 588\,000\ m^2$

$A_3 = 327.5 \times 40^2 = 524\,000\ m^2$; $A_4 = 496\,000\ m^2$

$A_5 = 444,000\ m^2$; $A_6 = 390\,000\ m^2$

$A_7 = 328\,000\ m^2$; $A_8 = 284\,000\ m^2$

$A_9 = 236\,000\ m^2$; $A_{10} = 184\,000\ m^2$

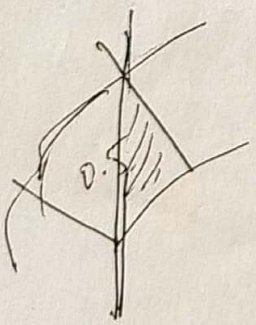
$A_{11} = 0$

Capacity = Volume: i) Trapezoidal Formula

$$V = d\left[\frac{A_1 + A_n}{2} + (A_2 + A_3 + A_4 + \cdots A_{n-1})\right]$$

$$= 2 \times 1000\left[\frac{640 + 0}{2} + (588 + 524 + 496 + 444 + 390 + 328 + 284 + 236 + 184)\right]$$

$$= \underline{7588 \times 1000}\ m^3 \text{ Ans}$$



ii) Prismoidal formula

$$V = \frac{d}{3}\left[(A_1 + A_n) + 4(A_2 + A_4 + \cdots A_{n-1}) + 2(A_3 + A_5 + \cdots A_{n-2})\right]$$

$$= \frac{2}{3} \times 1000\left[(640 + 0) + 4(588 + 496 + 390 + 284 + 184) + 2(524 + 444 + 328 + 236)\right]$$

$$= \frac{2}{3} \times 1000\left[640 + 7768 + 3064\right]$$

$$= \underline{7648 \times 1000}\ m^3 \text{ Ans.}$$

V=

Volume:

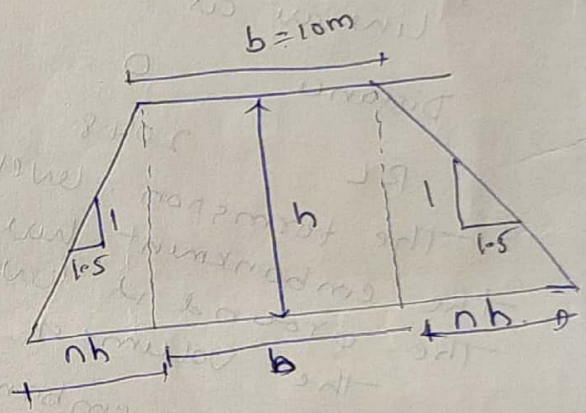
Trapezoidal formula:

Total volume $= d\left[\frac{A_1+A_n}{2} + A_2 + A_3 + \cdots + A_{n-1}\right]$

Simpson's rule (or) Prismoidal formula.

$$V = \frac{d}{3}\left[(A_1+A_n) + 4(A_2+A_4+\cdots A_{n-1}) + 2(A_3+A_5+\cdots A_{n-2})\right]$$

* A railway embankment Problems is 10m wide with side slopes 1.5 to 1. Assuming the ground to be level in a direction transverse to the centre line, calculate the Volume contained in a length of 120 metres. the centre heights at 20m intervals being in metres 2.2, 3.7, 3.8, 4.0, 3.8, 2.8, 2.5.



Soln For level section

The area is given by

$$A = \frac{1}{2}[b+b+nh+nh]h$$

$$A = \frac{1}{2}[2b+2nh]h$$

$$A = \frac{1}{2}\times 2[b+nh]h$$

$$A = (b+nh)h.$$

side slope is 1.5:1 $n = 1.5$, $b = 10$,

The areas under at different sections will be as follows.

$A_1 = [b+nh]h = [10+1.5\times 2.2]2.2 = 29.26\,m^2$

$A_2 = [10+1.5\times 3.7]3.7 = 57.54\,m^2$

$A_3 = [10+1.5\times 3.8]3.8 = 59.66\,m^2$

$A_4 = [10+1.5\times 4.0]4.0 = 64.00\,m^2$

$A_5 = [10+1.5\times 3.8]3.8 = 59.66\,m^2$

$A_6 = [10+1.5\times 2.8]2.8 = 39.76\,m^2$

$A_7 = [10+1.5\times 2.5]2.5 = 34.37\,m^2$

Volume by trapezoidal rule is given by

$$V = d\left[\frac{A_1+A_n}{2} + A_2 + A_3 + \cdots A_{n-1}\right]$$

$$V = 20\left[\frac{29.26+34.37}{2} + 57.54 + 59.66 + 64 + 59.66 + 39.76\right]$$

$$V = 6258.9\,m^3$$

Volume of prismoidal rule is given by

$$V = \frac{d}{3}\left[(A_1 + A_7) + 4[A_2 + A_4 + A_6] + 2[A_3 + A_5]\right]$$

$$V = \frac{20}{3}\left[(29.26 + 34.37) + 4[57.54 + 64 + 39.76)] + 2[59.66 + 59.66]\right]$$

$$\boxed{V = 6316.5 m^3}$$

(2) A railway embankment 400m long is 12m wide at the formation level and has the side slope of 2 to 1. The ground levels at every 100 m along the centre line are as under

Distance	0	100	200	300	400
RL	204.8	206.2	207.5	207.2	208.3

The formation level at (0) chainage is 207.00 and the embankment has a raising gradient of 1 in 100. The ground is level across the centre line. calculate the volume of earthworks.

Sol: Since the embankment level is to have a raising gradient of 1 in 100 the formation level at every section can be easily calculated as follows (b)

Distance	Ground (RL)	Formation level	Depth of filling
0	204.8	207.00	2.2
100	206.2	208.00	1.8
200	207.5	209.00	1.5
300	207.2	210.00	2.8
400	208.3	211.00	2.7

Area of the section is given by $A = (b + nh)h$

where $b = 12$, $n = 2$, $h =$

$A_1 = [12 + 2 \times 2.2]2.2 = 36.08 m^2$

$A_2 = [12 \times 2 \times 1.8]1.8 = 28.06 m^2$

$A_3 = [12 \times 2 \times 1.5]1.5 = 22.50 m^2$

$A_4 = [12 \times 2 \times 2.8]2.8 = 49.28 m^2$

$A_5 = [12 \times 2 \times 2.7]2.7 = 46.98 m^2$

Trapezoidal Rule

$$V = d\left[\frac{A_1 + A_n}{2} + A_2 + A_3 + \cdots A_{n-1}\right]$$

$$V = 400\left[\frac{36.08 + 46.98}{2} + 28.06 + 22.50 + 49.28\right]$$

$$V = 14.137 m^3$$

Volume of Prismoidal Rule

$$V = \frac{d}{3}\left[(A_1 + A_n) + 4[A_2 + A_4 + \cdots A_{n-1}] + 2(A_3 + A_5 + \cdots A_{n-2})\right]$$

$$V = \frac{400}{3}\left[(36.08 + 46.98) + 4[28.06 + 49.28] + 2[22.50]\right]$$

$$V = 14.581 m^3$$

Trapezoidal Rule - Volume

$$V = d\left[\frac{A_1 + A_5}{2} + A_2 + A_3 + A_4\right]$$

$$V = 400\left[\frac{36.08 + 46.98}{2} + 28.06 + 22.50 + 49.28\right]$$

$$V = 14.137 m^3$$

Volume of prismoidal rule.

$$V = \frac{d}{3}\left[(A_1 + A_5) + 4(A_2 + A_4) + 2(A_3)\right]$$

$$V = \frac{400}{3}\left[36.08 + 46.98\right] + 4(28.06 + 49.28) + 2[22.50]$$

$$V = 14.58 (m^3)$$

IV Area from planimeter:

Planimeter is a mechanical instrument devised by Amsler for measuring areas of irregular figures. It has three major units.

1. "Anchor arm" of fixed length having a "Pivot" and "Anchor point with weight".
2. "Tracing arm", graduated and of variable length with a "tracing point"
3. "Measuring unit" attached to tracing arm having a disc, and graduated wheel with Vernier.

During its use, planimeter is supported by i) Anchor point, ii) Tracing point and iii) periphery of the wheel.

Use of planimeter in measuring the area:

1. Position of measuring unit is adjusted based on scale setting.
2. Anchor point is located either outside or inside of the area to be traced with the tracing point.
3. Tracing point is placed on any marked point on the area. Initial reading (IR) is taken from disc and wheel graduations.
4. The tracing point is then moved over the periphery of the area carefully till the tracing point returns to the first marked point. The final reading (FR) is taken. While tracing the area, it should also be noted that the number of times (N) the '0' (zero) of disc passes the index "clockwise or anticlockwise".
5. The area(A) is then calculated from the following formula.

$$A = M(FR - IR \pm 10N + C)$$

where M = multiplying constant
& C = additive constant
} → (Supplied by the manufacturer)

Note: (i) + Sign is used when Zero passes the index in clockwise direction
− Sign is used when Zero passes the index in anticlockwise direction

✓ (ii) C - Value is used only when the anchor point is inside the area

? - - - (iii) $M = L \times d$ L = length of tracing arm, cm
d = dia of measuring wheel, cm.

? Zero Circle: The quantity IR is known as the area of Zero

The Zero circle is defined as the circle, around the circumference of which, if tracing point is moved, the wheel will simply slide (without rotation) on the paper without change in the reading. (Sometimes

Digital Planimeter: This is an improvement over the conventional planimeter. It is a micro-processor based unit which has sensors to determine the length of a line or area covered by tracer.

Features: (i) Control panel: This has a display panel which displays the length or area. It has set of keys. Keys help in setting units, vertical scale, & horizontal scale independently. Summation key, memory store key, memory recall key etc are also available.

ii) Roller: Wheel is used to provide stable and precise measurement

iii) Tracer arm: - With tracing point is used to trace the given length of line or area. A magnifying lens may may be provided over the tracing point in the arm, for clearer view of line to be traced.

iv) Mode switch: This helps in shifting from "point" mode to the "continuous" mode.

The digital planimeter gets power supply from "nickel - Cadmium" cell (rechargeable)

Procedure: i) The power is switched on. ii) With the help of keys, units, vertical scale, & horizontal scale are set iii) The tracer point is placed on the marked point and the "start switch" is pressed.

iv) The tracer point is carefully moved over the boundary till it returns to the starting point.

v) The end key is pressed to get the display of the area.

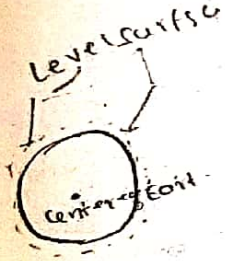
vi) The instrument is switched off.

Module: 3

LEVELLING:

Levelling may be defined as the art of determining the relative heights or elevations of points or objects on the earth's surface. It deals with the measurements in a vertical plane.

DEFINITIONS:



1. Level Surface: Any surface parallel to mean spheroidal surface of earth is said to be a level surface. Since the earth is assumed to be spherical, a level surface is regarded as a curved surface. Water surface of a still lake is considered to be a level surface. A "level line" is a line lying in a level surface. It is normal to plumb line at all points. (Fig 1)

2. Horizontal plane: Any plane tangential to the level surface at a point is known as horizontal plane.
A "horizontal line" is any line lying in a horizontal plane. At any point, the horizontal line is perpendicular to the plumb line (fig 1)

3. Vertical Plane: The direction indicated by the plumb line (direction of gravity) is known as the "vertical line". Any plane (Fig 1). Any plane perpendicular passing through the vertical line is known as the "Vertical plane".

4. Datum Surface or line: This is an imaginary level surface or level line from which the vertical distances of different points are measured. (Fig 1) In India, the datum adopted for the "Great Trigonometrical Survey" (GTS) is the "Mean Sea Level" (MSL at ~~Karachi~~ Mumbai.

5. Elevation: The elevation of a point is its vertical distance above or below datum. The elevation of a point is plus or minus according as the point is above or below the datum. (Fig 1. It is also known as "reduced level" (R.L)

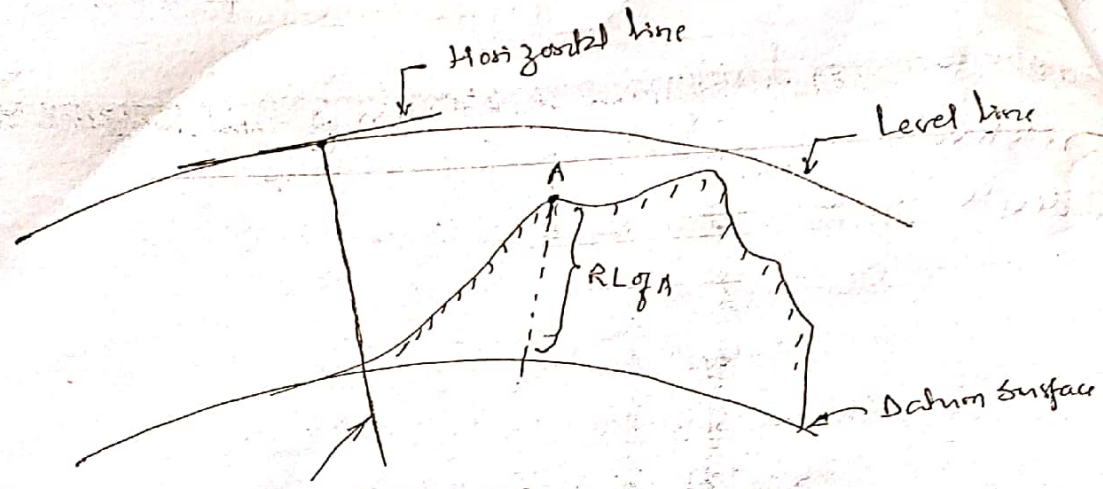


Fig 1.

6. Bench-mark (BM): It is a fixed reference point of known elevation. (Fig 2)

7. Back Sight (B.S) This is the first reading taken in any setup of instrument, after the levelling has been perfectly done, on a point of known elevation. (Fig 2)

8. Fore Sight (F.S) This is the last reading taken in any set up of instrument on a point, whose elevation is to be determined. (Fig 2)

9. Intermediate Sight (I.S): This is any other staff reading between "back sight" and "fore sight" (Fig 2)

10 Change Point (CP): It is a point indicating shifting of the instrument. It is the staff station on which "fore sight" is taken from one set up of instrument and "Back Sight" is taken from the next set up of instrument. It is also called as "Turning Point" (T.P) (Fig 2)

11. Line of collimation: It is an imaginary line passing through the intersection of cross-hairs at the diaphragm and the optical centre of the object glass, and its continuation. It is also called as "line of sight". The horizontal plane generated line of collimation is called "Plane of collimation".

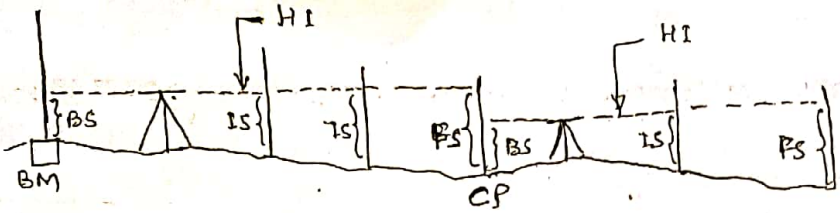


Fig 2

12. Height of Instrument (HI): When the levelling of instrument is properly levelled, the RL of line of collimation is known as "Height of Instr."

Bench Marks: A bench mark is a fixed reference point of known elevation. There are four kinds of bench marks. They are

i) GTS (Great Trigonometric Survey) bench marks
ii) Permanent bench marks.
iii) Arbitrary bench marks
iv) Temporary bench marks

GTS bench marks are the bench marks established with very high precision at intervals over the country by the "Survey of India department" of India. The values of reduced levels, the relevant positions and the number of bench marks are given in a catalogue published by the Survey of India department. The MSL at ~~Karachi~~ Mumbai has been taken as the datum.

Permanent bench marks are the bench marks established between GTS bench marks by the govt agencies such as P.W.D, on a clearly defined and permanent points such as top of parapet wall of a bridge or culvert, kilometer stone etc. Their positions are marked on a flat surface by a rectangle (fig 1). On a vertical surface, such as a wall, they are marked in the form of an arrow and horizontal groove (fig 2)

fig 1

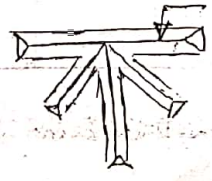


fig 2
(on Vertical Surface)

Arbitrary bench marks are the bench marks, the RLs of which are assumed arbitrarily.

Temporary bench marks: are the bench marks established at the end of days work. These should be carefully established on a definite and permanent objects.

Levelling instruments:

The instruments commonly used in levelling are

1. A level
2. Levelling staff.

1. Level:

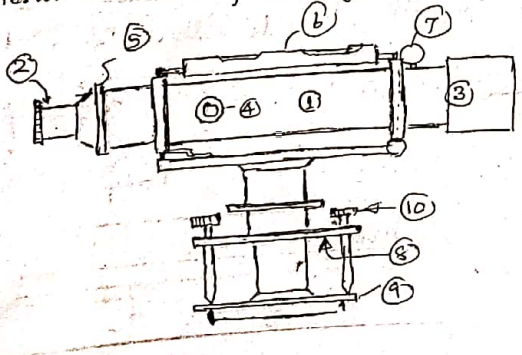
The purpose of a level is to provide a horizontal line of sight. It essentially consists of

i) a telescope to provide line of sight
ii) a level tube to make line of sight horizontal.
iii) a levelling head to bring the bubble to its centre of run
iv) a tripod to support the instrument.

There are various types of levels used in levelling. Among them, the commonly used levels are

i) Dumpy level
iii) Automatic level
ii) Tilting level

i) Dumpy level: The various parts of dumpy level are shown in the following diagram. It is supported on a tripod.



1. Telescope
2. Eye Piece
3. objective with ray shade
4. focusing screen
5. Diaphragm
6. Longitudinal bubble
7. Transverse bubble
8. Tribrach
9. Trivet
10. Foot screws

} Levelling head.

The principal lines or axes of a dumpy level are

i) Line of sight:- "Line joining intersection of cross hairs at the diaphragm and optical centre of objective and its continuation".

ia) Axis of telescope:- "Line joining the optical centres of eyepiece & objective". (Both i & ia coincide)

ii) Bubble Axis:- "Tangential line to the bubble tube at its centre".

iii) Vertical axis:- "Axis about which the instrument rotates in a horizontal plane".

The desired relationships are

i) Bubble axis should be perpendicular to vertical axis.

ii) Line of sight should be parallel to Bubble axis.

The adjustments done for establishing the desired relationships are called "Permanent adjustments".

Temporary adjustments of a level:

These are the adjustments made at every setup of instruments before taking staff readings. This consists of the following.

1. Setting up the level:
2. Levelling up and
3. Parallax elimination.

1. Setting up the level: i) Fixing the instrument to the tripod
ii) Levelling the instrument approximately by deg adjustment.

2. Levelling up: i) Telescope is turned to keep the longitudinal bubble parallel to a pair of foot screws. (fig 1) These two foot screws are turned simultaneously inwards or outwards, till the bubble comes to the centre of its run.

Fig 1

ii) Telescope is turned through 90°, say clockwise direction so that the bubble axis line of sight passes over the third foot screw. This third foot screw is turned clockwise or anticlockwise, till the bubble is in the centre of its run.

iii) Telescope is turned through 90° in anticlockwise direction so that its bubble axis is parallel to the pair of foot screws. These two foot screws

are turned inwards or outwards till the bubble is at the centre

iv) Step iii) is repeated.

v) Steps iii) and iv) are repeated till the bubble remains central in these two position.

vi) From the last position, the telescope is rotated through 180° (↻ or ↺). If the bubble remains central, it is in permanent adjustment, If not, it needs permanent adjustment.

3. Elimination of Parallax: Parallax is the apparent movement of the image with the movement of eye. This occurs when the image of the object does not fall in the plane of the diaphragm. Parallax is eliminated in two steps

i) Focusing the eye piece: A sheet of white paper is held in front the object glass. Eye-piece is rotated till the cross hairs are seen sharp and distinct.

ii) Focusing the objective: Telescope is turned towards the levelling staff, and the focussing screw is turned till the image appears clear and sharp.

Assignment: → Other Types of levels – brief description of

i) Wye level
ii) Cookes reversible level
iii) Cushing's level
iv) Tilting level
v) Automatic level.

} From any of the Text books.

Levelling staff: A levelling staff is a straight rectangular wooden member, graduated into metres and smaller divisions. The purpose of levelling staff is to determine the amount by which the station is above or below the line of sight. There are two types of levelling staves. They are 1. Self reading staff and
2. Target staff.

1. Self reading staff: The three forms of self reading staff are i) Solid staff ii) folding staff and iii) Telescopic staff. (Sopwith pattern) A solid staff is usually 3m long. The folding staff is made of two pieces, each of 2 m. Two pieces are hinged at their ends. The telescopic staff is made of 3 pieces, arranged in three telescopic lengths. When fully extended it usually of 4 m. length. The 4 m staff has solid top length of 1.25 m sliding into the central box of 1.25 m. The central box in turn slides into lower box of 1.5 m length. Self reading staff is to be read directly by the instrument man through the telescope.

2. Target staff: It is 13 feet long and consists of two lengths, held together by means of brass clamping screw. One of the lengths can be slided over the other. Both the pieces The upper piece is of 6' length and the lower piece is of 7' length. It is graduated in feet, tenths, and hundredths and the Vernier of the target enable the readings to be taken upto a thousandth part of a foot.

For taking the reading the level man directs the staffman to raise or lower the target till it is bisected by the line of sight. The staffman clamps the target and then takes the reading.

Mean sea level: It is the average height of the sea for all stages of the tides. At any particular place it is derived by averaging the hourly tide heights over a long period of 19 years. In India the mean sea level used is that at Karachi. In all important surveys this is taken as datum. Mumbai

Types of levelling:

1. Simple levelling: When the difference of level between two points is determined by setting the level mid-way between the points, the process is called 'simple levelling'.

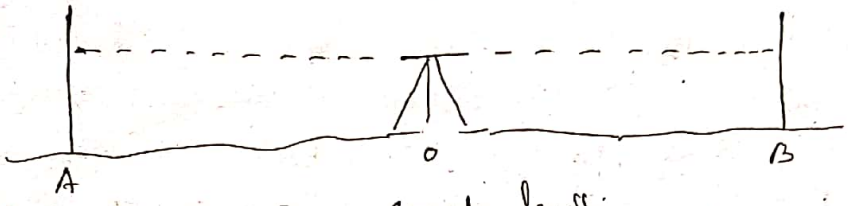


Fig. Simple levelling

2. Differential levelling: Differential levelling is adopted when
   a) the points are at a great distance
   b) the difference of elevation between the points is large
   c) there are obstacles between the points

This method is known as "fly levelling" or "Compound levelling" or "Continuous levelling". In this method, the level is set up at several suitable positions and staff readings are taken (Ref. fig)

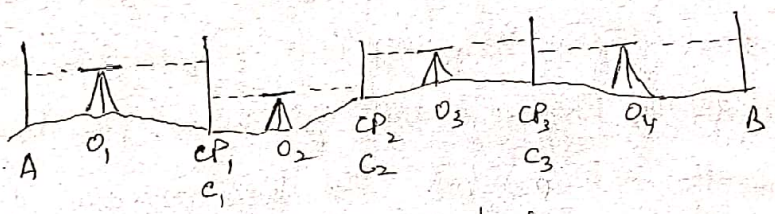
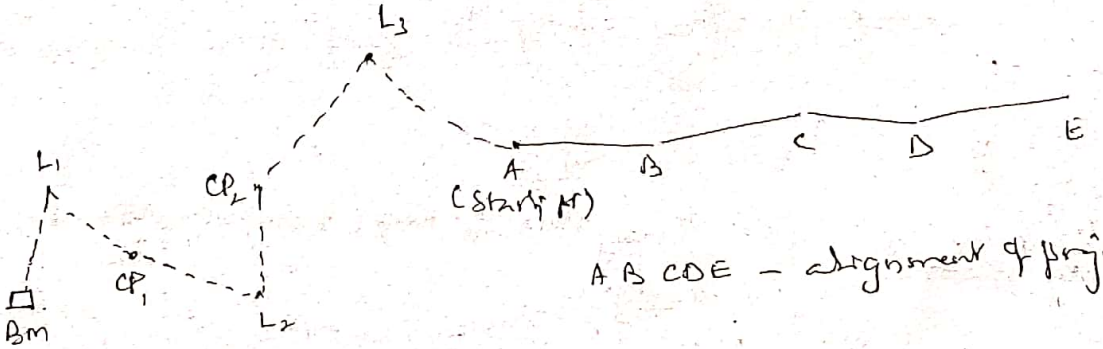


Fig. Differential levelling

3. Fly levelling: When differential levelling is done in order to connect a BM to the starting point of the alignment of any project is called 'fly levelling'.



ABCDE – alignment of project

Fig Fly levelling (dotted lines)

staff held vertically on Q and the

4. Check levelling: The Fly levelling done at the end of day's work to connect the finishing point with the starting point on that particular day is known as 'check levelling'. It is undertaken to check the accuracy of days work.

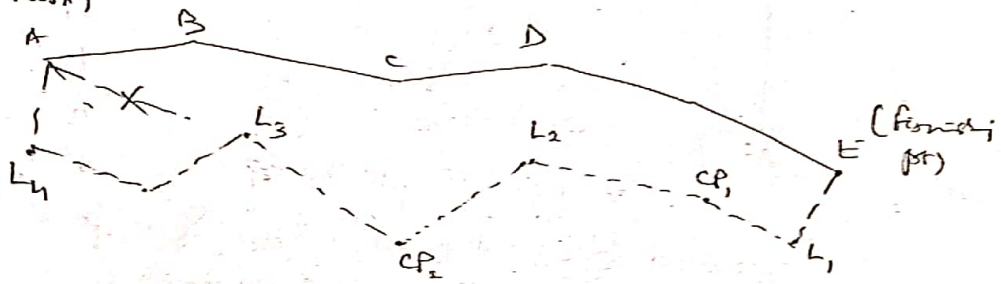


fig Check levelling (dotted line)

5 Profile levelling: It is the operation to determine the elevations of points spaced apart at known distances along a given line, the purpose of this levelling is to obtain the ground profile. This levelling is also called "longitudinal sectioning" or "Simply" sectioning. Profile surveying is very useful for projects like construction and design of highways, railways, canals, pipe lines etc to determine the cut and fill. The field procedure of profile levelling is indicated in the following fig. (fig 1)

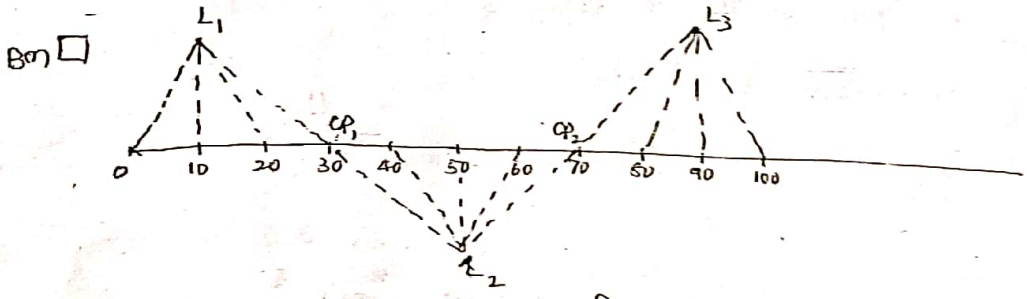
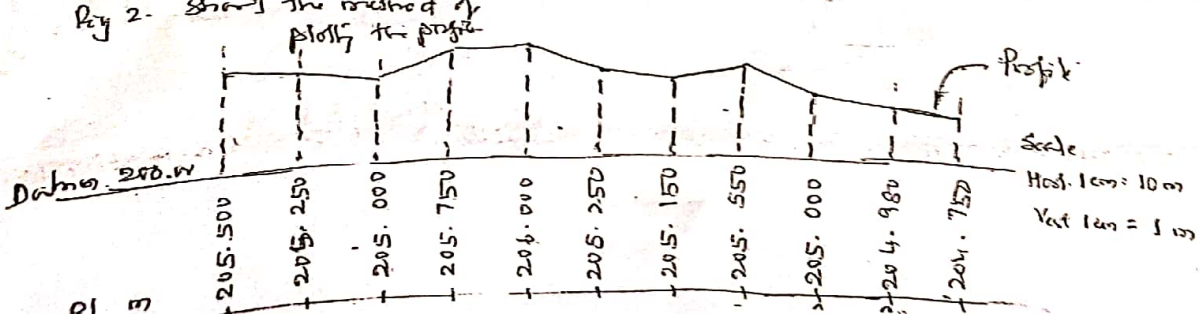


fig. plan of Profile levelling (field procedure)

fig 2. Shows the method of plotting the profile



Cross sectioning: It is the operation of levelling to determine the elevation of the points at right angles on either side of the centre line of a project like highway or railway. This is done to obtain the details of the profile perpendicular to the ℄. The longitudinal sections together with cross sectioning helps in estimating the quantity of earthwork (excavation or filling)

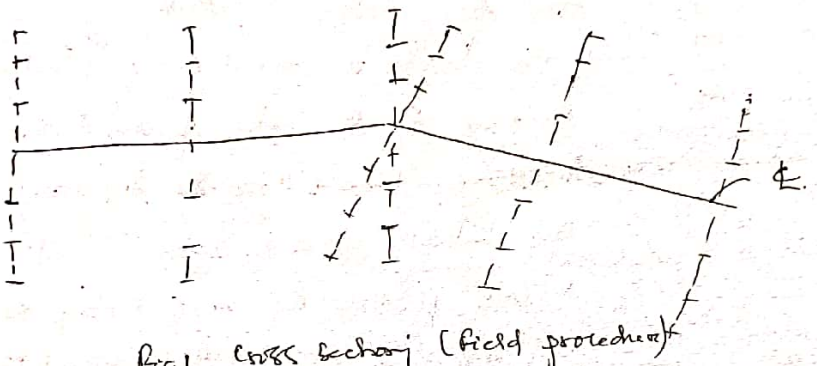


Fig 1 Cross sectioning (field procedure)

Fig 2. Shows the method of plotting.

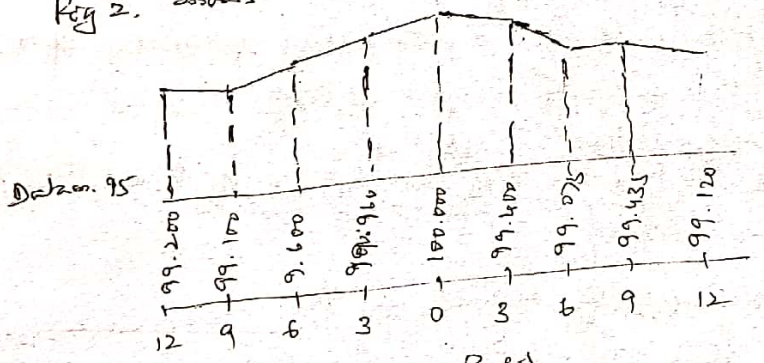
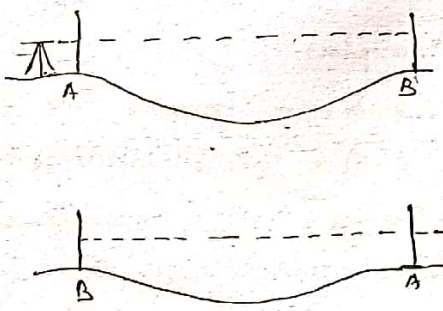


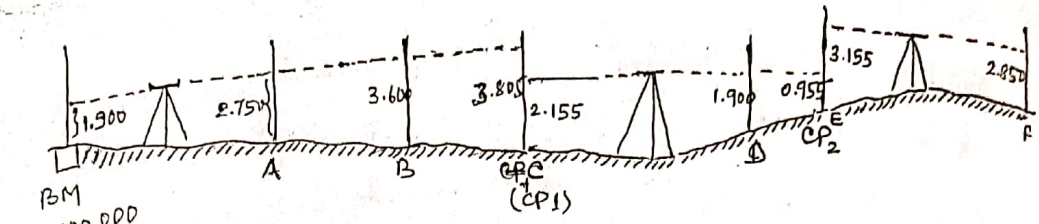
Fig 2. C/S Profile

Station	Distances M		
	L	C	R
BM		0	
L1	3		
L2	6		
L3	9		
R1			3
R2			6
P1			9

7. Reciprocal levelling: It is the operation of levelling in which the difference in levelled elevation between two points is accurately determined by two sets of reciprocal observations. This is used when the inst cannot be set up betn two points due to an obstruction such as valley, river etc. (Ref. fig



Method of entering the readings in a page of level book:



B.S	I.S	F.S	H.I or(PC)	RL	Remarks
1.900				100.000	B.M. (details)
	2.750				A
	3.600				B
2.155		3.805			C - CP_1
	1.900				D
3.155		0.955			E
		2.850			F

Methods of reducing levels: There are two methods of reducing levels. They are 1. Height of Instr. method
2. Rise and Fall method.

1. **Height of Instrument method:**

Eqns Used i) HI = RL of BM + BS/

ii) R.L = HI − IS/F.S

Arithmetic Check :- $\Sigma B.S - \Sigma F.S$ = Last R.L − First R.L.

B.S	I.S	F.S	H.I	R.L	Remarks
1.900			101.900	100.000	BM
	2.750			99.150	A
	3.600			98.300	B
2.155		3.805	100.250	98.095	C - CP_1
	1.900			98.350	D
3.155		0.955	102.450	99.295	E - CP_2
		2.850		99.600	F.
Σ 7.210		Σ 7.610			

Arith. Check: $\Sigma BS - \Sigma FS$ = last RL − first RL

7.210 − 7.610 = 99.600 − 100.000

− 0.400 = − 0.400 ∴ O.K

2 Rise and fall method:

Eqns used: i) First reading − Second reading = +ve Rise
(Taken from a fig like below) −ve Fall.

ii) R.L = R.L of Previous Point + Rise
OR
RL = R.L of Previous Point − Fall.

Arithmetic check:

$\Sigma Rise - \Sigma Fall = \Sigma BS - \Sigma FS$ = Last RL − first RL

BS	IS	FS	Rise	Fall	R.L	Remarks
1.900					100.000	BM
	2.750			−0.850	99.150	A
	3.600			−0.850	98.300	B
2.155		3.805		−0.205	98.095	C − CP_1
	1.900		+0.255		98.350	D
3.155		0.955	+0.945		99.295	E − CP_2
		2.850	+0.305		99.600	F
Σ 7.210		Σ 7.610	Σ 1.505	Σ 1.905		

Arithmetic Check:

$\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall$ = Last RL − first RL

$7.210 - 7.610 = 1.505 - 1.905 = 99.600 - 100.000$

$-0.400 = -0.400 = -0.400$ ∴ OK.

Comparison between HI method and Rise and fall method

HI Method. (Collimation method)	Rise & Fall method
1. It is rapid as it involves few calculations	It is laborious involving several calculations
2. There is no check on the RL of intermediate sight points. and hence errors in the calculation of RL of intermediate sight pts cannot be detected.	There is a check on the RL of intermediate sight points and hence no errors in the calculation of RLs
3. Check $\Sigma BS - \Sigma FS$ = last RL − first RL	Check $\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall$ = last RL − first RL

Points to be remembered while entering the levelling books:

1. The first reading of any set up is entered in the BS column, the last reading in the FS column and the other readings in the IS column.
2. A page always starts with a BS reading and finishes with an FS reading.
3. If a page finishes with an IS reading, the reading is entered ~~in~~ in the IS and FS columns on that page and brought forward to the next page by entering it in the BS and IS columns.
4. The FS and BS of any change point are entered in the same horizontal line.
5. The HI is entered in the same horizontal line in which the corresponding BS was entered.
6. Important note, bench marks and change points should be clearly described in the remark column.

EXAMPLES:

① The following readings were observed successively with a levelling instrument. The instrument was shifted after 5th and 11th readings Draw a page of level book and determine the RL of various points by (a) Rise and Fall method, if the RL of the point on which first ready was taken was 264.350 m.

(BS) (FS) (BS)
0.485, 1.020, 1.785, 3.395, 3.875, 0.360, 1.305,
(FS) (BS) (FS)
1.785, 2.675, 3.385, 3.885, 1.835, 0.435, 1.705

Soln:

BS	IS	FS	Rise	Fall	RL	Remarks
0.485					264.350	BM
	1.020			-0.535	263.815	
	1.785			-0.765	263.050	
	3.395			-1.610	261.440	
0.360		3.875		-0.480	260.960	CP 1
	1.305			-0.945	260.015	
	1.785			-0.480	259.535	
	2.675			-0.890	258.645	
	3.385			-0.710	257.935	
1.835		3.885		-0.500	257.435	CP 2
	0.435		+1.400		258.835	
		1.705		-1.270	257.565	
Σ 2.680		9.465	1.400	8.185		

Check.

$\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall$ = Last RL - First RL

$2.680 - 9.465 = 1.400 - 8.185 = 257.565 - 264.350$

$-6.785 = -6.785 = -6.785$ ∴ Ok.

(2) The following consecutive readings were taken with a level and a 4 m levelling staff on a continuously sloping ground at common interval of 30 m

0.855, (on A), 1.545, 2.335, 3.115, 3.825, 0.455, 1.380, 2.055, 2.855, 3.455, 0.585, 1.015, 1.850, 2.755, 3.845 (on B)

The RL of A was 380.500 m Make entries in a level page & reduce levels of all the points.
Determine the Gradient of AB

Solution:

BS	IS	FS	HI	RL	Remarks	Chainage
0.855			381.355	380.500	A	0
	1.545			379.810		30
	2.335			379.020		60
	3.115			378.240		90
0.455		3.825	377.985	377.530	CP-1	120
	1.380			376.605		150
	2.055			375.930		180
	2.855			375.130		210
0.585		3.455	375.115	374.530	CP-2	240
	1.015			374.100		270
	1.850			373.265		300
	2.755			372.260		330
		3.845		371.270	B	360
Σ 1.895		11.125				

Check: $1.895 - 11.125 = 371.270 - 380.500$

$-9.230 = -9.230$

Gradient = $\frac{\text{Diff in level}}{\text{hori. dist}} = \frac{9.230}{360} = \frac{1}{39}$ ie 1 in 39 (Falling gradient)

(3) During fly levelling the following notes were made.

B.S : 0.620, 2.050, 1.420, 2.630 }
F.S : 2.440, 1.350, 0.530, 2.410 }

The first reading was taken on BM of RL 250.000. Enter the readings and calculate the RLs of various points.

B.S	I.S	F.S	HI	RL	Remarks
0.620			250.620	250.000	B.M
2.050		2.440	250.230	248.180	CP_1
1.420		1.350	250.300	248.880	CP_2
2.630		0.530	252.400	249.770	CP_3
		2.410		249.990	CP_4
Σ 6.720		6.730			

ΣBS − ΣFS = Last RL − First RL

∴ Ok.

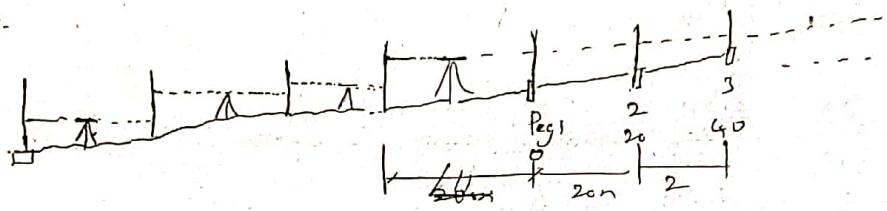
Ex ④ In fly levelling, from a BM of RL 140.605, the following readings were observed.

B.S: 1.545, 2.695, 1.415, 2.925

F.S: 0.575, 1.235, 0.595.

From the last position of the instrument, six pegs at 20 m intervals are to be set out on a uniformly rising gradient of 1 in 50, the first peg is to have an RL of 144.000. Find the staff readings and RL of the pegs.

Soln.



BS	I.S	F.S	H.I	RL	Rise	Fall	Remarks
1.545			142.105	140.605			
2.695		0.575	144.270	141.575			
1.415		1.235	144.450	143.035			
2.925		0.595	146.780	143.855			
	2.780			144.000	0	0	Peg 1
	2.380			144.400	20	20	2
	1.980			144.800	20	40	3
	1.580			145.200	20	60	4
	1.180			145.600	20	80	5
		0.780		146.000	20	100	6
Σ 8.580		3.185					

Gradient from Peg 1 to Peg 6 is 1 in 50 (upgradient)

∴ Rise for 20 m = $\frac{1}{50} \times 20 = 0.400$

∴ RL of Peg 2 = RL of Peg 1 + 0.4 = 144.000 + 0.400 = 144.400

∴ Check:

$8.580 - 3.185 = 146.000 - 140.605$

$5.395 = 5.395$ ∴ OK.

(B5) Starting from a point A of elevation 92.5 m, levels were taken for a section extending to a point B, the reduced level of which was found to be 98.15 m. Check levels were carried back along the shortest route from B to A, the readings being given below. Find the error of closure on the starting pt.

BS	FS	Remarks
1.120	—	B
0.740	3.050	
1.800	2.795	
2.490	0.375	
0.730	1.235	
1.820	3.390	
0.720	1.915	
	2.290	A

Soln:

BS	IS	FS	HI	RL	Remarks
1.120			99.270	98.150	B
0.740		3.050	96.960	96.220	
1.800		2.795	95.965	94.165	
2.490		0.375	98.080	95.590	
0.730		1.235	97.575	96.845	
1.820		3.390	96.005	94.185	
0.720		1.915	94.810	94.090	
		2.290		92.520	A

9.420 15.050

−5.630 −5.630

Error of closure. 92.520 − 92.500 = 0.020

(B)

Ex: A page of level book is shown in the following table. Fill in the missing readings and calculate the RL of all points. Apply the usual checks.

Station	BS	IS	FS	Rise	Fall	RL	Remarks
1	2.150					450.000	BM - I
2	1.645		? 1.650	0.500		450.500	
3		2.345			? - 0.700	449.800	
4	? 1.425		1.965	? 0.380		450.180	
5	2.050		1.825		(-) 0.400	449.780	
6	? 1.690		? 0.330	? 1.720		451.500	BM - II
7	1.690		1.570	0.120		451.620	
8	2.865		2.100		? - 0.410	451.210	
			? 2.825 ~~2.060~~	? 0.040		451.250	BM - III
	Σ 13.515		~~Σ~~ 12.265	2.760	1.510		

Sol: Stn 1 & 2 $2.150 - ? = +0.500 \therefore ? = 2.150 - 0.500 = 1.650$

RL of 2 = RL of 1 + Rise = 450 + 0.500 = 450.500

2-3 $1.645 - 2.345 = ? \therefore ? = -0.700$ (Fall)

$\therefore$ RL of 3 = 450.500 - 0.700 = 449.800

3-4 $2.345 - 1.965 = ? \therefore ? = 0.380$ (Rise)

RL of 4 = 449.800 + 0.380 = 450.180

4-5 $? - 1.825 = -0.400 \therefore ? = 1.425$

R of 5 = 450.180 - 0.400 =

5-6 RL of 6 = RL of 5 + ~~Rise~~ ? $\therefore ? =$ RL of 6 - RL of 5

= 451.500 - 449.780

~~2.050 -~~ ?

=

$2.050 - ? = 1.720 \therefore ? = 0.330$

6-7 $? - 1.570 = 0.120 \therefore ? = 1.690$

RL of 7 = 451.500 + 0.120 451.620

7-8

Check $1.250 = 1.250 = 1.250$ $\therefore$ OK

Ex: While constructing a building the bottom of a balcony A was taken as a BM, the R.L of which was 100.000 m. Calculate the R.L of the bottom of the chajja B, given the following notes. Enter out the readings in the form of a page of level book and reduce the levels.

Reading on inverted staff on Bm (on A) = 1.250 m
Reading on the Peg P on the ground = 0.685 m (chajja glass)
Reading on the Peg P on the ground = 3.290 m
Reading on inverted staff at bottom of chajja (on B) = 1.465 m

Soln:

Station	BS	IS	FS	HI	RL	Remarks
A	-1.250			98.750	100.000	BM
P	3.290		0.685	101.355	98.065	CP
B			-1.465		102.820	Bottom of chajja
	2.04		-0.780			

HI_1 = R.L of Bm + BS = 100.000 + (-1.250) = 98.750

R.L of P = HI - FS = 98.750 - 0.685 = 98.065

HI_2 = R.L of P + BS = 98.065 + 3.290 = 101.355

R.L of B = HI - FS = 101.355 - (-1.465) = 102.820

Check: 2.04 - (-0.780) = 102.820 - 100.000

2.820 = 2.820 ∴ OK

Rise & Fall method:

Stn	BS	IS	FS	Rise	Fall	R.L of	Remarks
A	-1.250					100.000	BM
P	3.290		0.685		-1.935	98.065	CP
B			-1.465	4.755		102.820	Bottom of chajja
	2.04		-0.780				

AP -1.250 - 0.685 = -1.935 (Fall)

R.L of P = 100.000 - 1.935 =

PB. 3.290 - (-1.465) = +4.755 (Rise)

Check:

2.04 - (-0.780) = 4.755 - 1.935 = 102.820 - 100.00

2.820 = 2.820 = 2.820

SENSITIVENESS OF BUBBLE:

Definition: "Angular Value of one division of bubble tube".

Determination: (Ref. fig)

(i) Two points are marked at a convenient distance of about D m (say 50 to 100 m)

(ii) The level is set up at one of the stations. With the bubble in the central position of its run, the staff reading S_1, held at the other station, is noted.

(iii) The bubble is now moved out of its centre by n divisions by foot screws. If the value of one division of the bubble tube is l, m, then the distance moved by the bubble is nl, m. In this bubble position, the staff reading S_2 m is noted. The difference in staff reading = staff intercept = error in staff reading = $S = S_2 - S_1$

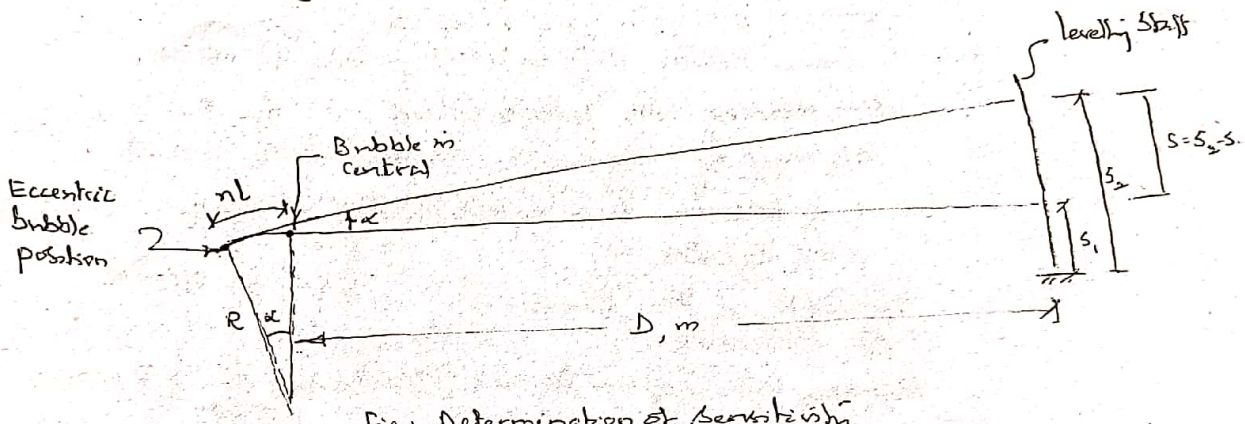


Fig: Determination of Sensitivity

Let α - be the angle with which the bubble is moved out of its centre.

R - be the radius of curvature of the bubble tube.

Arc length $nl = R\alpha$ or $\boxed{\alpha = \frac{nl}{R}}$ — (1)

In equation (1) if $n = 1$, α will be the angular value of one division, which is nothing but the sensitivity of bubble, say α'

ie $\alpha' = \frac{1 \times l}{R}$ or $\underset{\text{(radians)}}{\alpha} = \frac{l}{R}$

or $\underset{\text{(Seconds)}}{\alpha} = \frac{l}{R} \times \left(\frac{180}{\pi} \times 60 \times 60\right)$

or $\boxed{\underset{\text{(Seconds)}}{\alpha} = \frac{l}{R} \times 206265}$ — (1a)

Also from fig, $\tan\alpha = \frac{S}{D}$

Since α is very small $\tan\alpha = \alpha$ $\therefore \boxed{\alpha = \frac{S}{D}}$ — (2)

Equating (1) and (2)

$\frac{nl}{R} = \frac{S}{D}$ or $\boxed{R = \frac{nlD}{S}}$ — (3)

Sensitivity of bubble depends upon

(i) Radius of curvature of tube - Larger the radius, greater will be the sensitivity
(ii) Diameter of the tube - Larger the diameter, greater will be the sensitivity
(iii) Length of the bubble - Larger the length, greater will be the sensitivity.
(iv) Viscosity of liquid in the tube - Lesser the viscosity, greater will be sensitivity.

Examples:

1) The reading taken on a staff, 100 m from the instrument with bubble central was 1.872 m. The bubble is then moved 5 divisions, out of the centre and the staff reading is observed to be 1.906 m. Find the angular value of one division of the bubble and the radius of curvature. Take the length of one division of bubble as 2 mm.

Data:

Soln: Distance between staff and instrument = D = 100 m.

Staff reading with bubble central = S_1 = 1.872 m.
Staff reading with bubble eccentric = S_2 = 1.906 m.
$\therefore S = 1.906 - 1.872 = 0.034$ m

No of divisions moved by bubble out of its centre = n = 5

Length of one division = $l = 2 \times 10^{-3}$ m.

Reqd: α' and R

Angular Value of one division = Sensitivity (Seconds) = $\alpha' = \frac{l}{R} \times 206265$ — (1)

Radius of curvature of bubble tube: $R = \frac{nlD}{S} = \frac{5 \times (2 \times 10^{-3}) \times 100}{0.034}$

$= 29.41$ m Ans

Substituting R value in eqn (1)

$\alpha' = \frac{2 \times 10^{-3}}{29.41} \times 206265 = 14.03''$ Ans.

2) If the bubble-tube of a level has a sensitivity of 30" per 2 mm division, find the error in staff reading on a vertically held staff at a distance of 150 m, caused by a bubble, 2 divisions out of the centre.

Soln:

Data: $\alpha' = 30''$; $l = 2 \times 10^{-3}$ m; D = 150 m; n = 2

Reqd: S and R

$\alpha' = \frac{l}{R} \times 206265$; $30 = \frac{2 \times 10^{-3}}{R} \times 206265$ $\therefore$ R = 13.75 m

$R = \frac{nlD}{S}$; $13.75 = \frac{2 \times (2 \times 10^{-3}) \times 150}{S}$ $\therefore$ S = 0.044 m Ans

Curvature and Refraction:

1. CURVATURE CORRECTION:

"The vertical distance between the horizontal line of sight and a level line at a particular place is called curvature correction". (Ref. fig 1) Curvature correction is applied for long sights. Due to curvature, the objects appear lower than what they really are. Curvature correction is always negative.

The formula for curvature correction can be derived as follows (Ref. fig 2)

In fig, AB = horizontal distance (as per the horizontal line of sight), km
AD = level line in level surface. (parallel to mean spheroidal surface)
AC = DC = Radius of the earth, km. (6370) = R
BD = C_c = Curvature correction.

From right angled triangle ABC, (right angled at A)

$$(BD + DC)^2 = AB^2 + AC^2$$

$$(C_c + R)^2 = D^2 + R^2$$

$$C_c^2 + 2RC_c + R^2 = D^2 + R^2$$

Since C_c is a very small value, C_c^2 is neglected.

$$\therefore C_c = \frac{D^2}{2R} \quad \text{(km)}$$

$$C_c = \frac{D^2}{2R} \times 1000 \quad \text{(m)}$$

$$C_c = \frac{D^2}{2 \times 6370} \times 1000 \quad \text{(m)}$$

$$\text{or } \boxed{C_c = 0.0785 D^2}$$

Note: C_c is in metre and D is in kilometer.

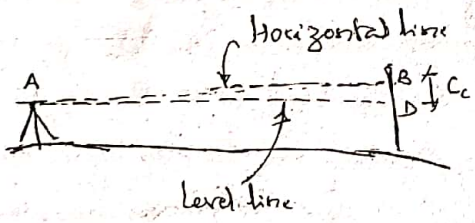


Fig 1

BD = CC

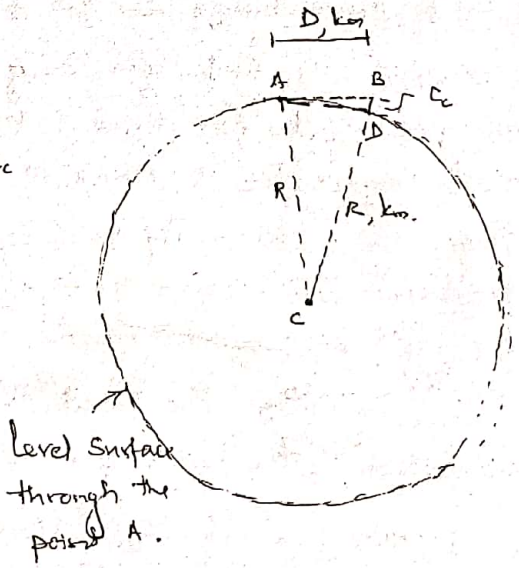


Fig 2

3) Find the radius of curvature of the bubble tube if the length of one division is 2 mm and angular value of one division is i) 20" and ii) 1'.

Soln: Data: $l = 2\times10^{-3}$ m i) $\alpha' = 20''$
ii) $\alpha' = 60''$

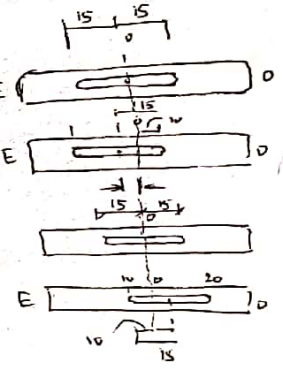
Reqd: R

i) $\alpha' = \frac{l}{R} \times 206265$; $20'' = \frac{2\times10^{-3}}{R} \times 206265$ $\therefore R = 20.63$ m Ans

ii) $\alpha' = \frac{l}{R} \times 206265$; $60'' = \frac{2\times10^{-3}}{R} \times 206265$ $\therefore R = 6.88$ m Ans

4) Find the radius of curvature of the bubble tube and the value of each 2 mm division from the following average reading of the ends of the bubble and a staff, kept at 80 m from the instrument.

	I	II
Staff reading	: 1.680 m	1.602 m
Eye piece end of bubble	: 20	10
Object glass end of bubble	: 10	20



Soln:
Case I: Bubble moved out of its centre by = $\frac{20-10}{2}$ = 5 div
Case II Bubble moved out of its centre by = $\frac{20-10}{2}$ = 5 div

$\therefore$ Total no of divisions moved by the bubble $= n = 5+5 = 10$

$R = \frac{n l D}{s} = \frac{(10)(2\times10^{-3})(80)}{(1.680-1.602)} = \frac{(10)(2\times10^{-3})(80)}{0.078} = \underline{20.51}$ m. Ans.

$\alpha' = \frac{l}{R} \times 206265 = \frac{2\times10^{-3}}{20.51} \times 206265 = \underline{20.1''}$ Ans

5) A three screw dumpy level, set up with the telescope, parallel to two foot screws is sighted on a staff, 100 m away. The line of sight is depressed by manipulating the foot screws until the bubble on the telescope reads 4.1 at the object glass and 14.4 at the eye piece end. The reading on the staff was 0.930 m. By similarly elevating the line of sight, the bubble readings were 12.6 at the object glass and 5.7 at the eye piece end, and the staff reading was 1.025 m.

Determine the sensitivity of the bubble and radius of curvature of the bubble, if the length of one division is 2.5 mm.

Soln: $D = 100$ m; $n = \left\{\left(\frac{14.4-4.1}{2}\right) + \left(\frac{12.6-5.7}{2}\right)\right\} = 8.6$ divisions

$s = 1.025 - 0.930 = 0.095$ m; $l = 2.5\times10^{-3}$ m; $\alpha' = ?$ and $R = ?$

$R = \frac{n l D}{s} = \frac{(8.6)(2.5\times10^{-3})(100)}{0.095} = \underline{22.63}$ m Ans

$\alpha' = \frac{l}{R} \times 206265 = \frac{2.5\times10^{-3}}{22.63} \times 206265 = \underline{22.78''}$ Ans.

2. REFRACTION CORRECTION: Rays of light are refracted when they pass through layers of air of varying density. Hence, when long sights are taken, the line of sight is refracted towards the earths surface. The refraction correction is taken as "one-seventh" of curvature correction.

ie Refraction correction = $C_R = \frac{1}{7}$ (Curvature correction)

$$C_R = \frac{1}{7} C_c$$

$$C_R = \frac{1}{7}(0.0785 C_c)$$

or $\boxed{C_R = 0.0112\, D^2}$

The Due to refraction, the objects appear higher than what they really are. Refraction correction is always positive.

COMBINED CURVATURE AND REFRACTION: (C_{CR})

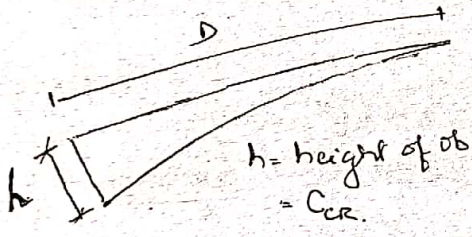
$$C_{CR} = 0.0785\, D^2 - 0.0112\, D^2$$

$$\therefore \boxed{C_{CR} = 0.0673\, D^2}$$

Note. C_{CR} is in metres and D is in kilometres

* C_{CR} is always negative

DISTANCE TO VISIBLE HORIZON: (D)



h = height of observer eye level
= C_{CR}.

$$C_{CR} = h = 0.0673\, D^2$$

or $D = \sqrt{\frac{h\,(m)}{0.0673}}$ (km)

Examples:

1) Find the combined correction for curvature and refraction for i) 100 m, ii) 1 km, iii) 50 km and iv) 100 km

Solu: $C_{CR} = 0.0673\, D^2$ C_{CR} is in metres and D is in kilometers

i) $C_{CR} = 0.0673\left(\frac{100}{1000}\right)^2 = 6.73 \times 10^{-4}$ m

ii) $C_{CR} = 0.0673(1)^2 = 0.0673$ m

iii) $C_{CR} = 0.0673(50^2) = 168.25$ m

iv) $C_{CR} = 0.0673(100^2) = 673$ m.

From the above result, it is seen that "curvature and refra correction may be neglected small lengths of sights but should considered for long sights.

2) In order to find the difference in elevation between two points P and Q, a level was set up upon PQ, 60 m from P and 1280 m from Q. The readings obtained on staffs kept at P and Q were respectively 0.545 m and 3.920 m. Find the true difference in elevation between P and Q.

Soln:

True difference in elevation between P and Q

= Corrected staff reading at P − Corrected staff reading at Q

Corrected staff reading at P = Observed reading − Combined curvature & refraction correction

$= 0.545 - 0.0673\left(\frac{60}{1000}\right)^2 =$

$= 0.545 - 0.0002$ (very small)

$= 0.545$ m.

Corrected staff reading at Q = Q. $3.920 - \left(\frac{1280}{1000}\right)^2 \times 0.0673$

$= 3.920 - 0.110$

$= 3.810$ m

∴ True difference in elevation = $0.545 - 3.810 = -3.265$ m

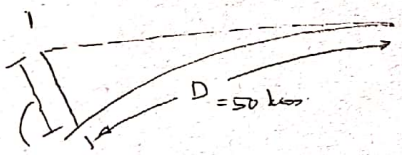
$= \underline{3.265}$ m (Fall from P to Q)

3) A light house is visible just above the horizon at a certain station at the sea level. The distance between the station and the light house is 50 km. Find the height of the light house.

Soln:

$h = 0.0673 D^2$

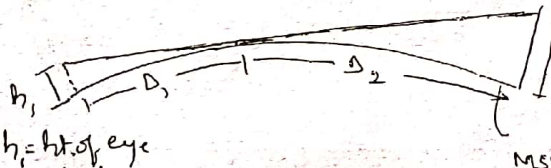
$h_{(m)} = 0.0673 \times 50^2 = \underline{168.25 \text{ m}}$ Ans.



h = height of light house.

4) An observer standing on the deck of a ship just sees a top light house. The top of the light house is 42 m above the MSL, and the height of observer eye is 6 m above the MSL. Find the distance of the observer from the light house.

Soln:



Distance betn observer & light house

$= D_1 + D_2$

$D_1 = \sqrt{\frac{h_1}{0.0673}} = \sqrt{\frac{6}{0.0673}} = 9.44$

$D_2 = \sqrt{\frac{h_2}{0.0673}} = \sqrt{\frac{42}{0.0673}} = 24.9$

∴ Dist. betn observer and light house

$= 9.442 + 24.981$

$= 34.423$ km.

RECIPROCAL LEVELLING:

This is an operation of levelling in which the difference in elevation between two points is accurately determined by two sets of reciprocal observations. Reciprocal levelling eliminates

i) error in instrument adjustment. (Collimation error)

ii) error due to curvature and refraction.

Let A and B be the two points and observations be made with a level having error in adjustment.

The level is set up a point near A and the staff readings are taken on A and B with the bubble in central position. Since the level is very near A, no error due to "curvature and refraction" and "collimation" will be induced in the staff reading at A. But there will be an error e in the staff reading at B.

The level is now shifted and set up at a point near B. The staff readings are taken on A and B. Since the level is very near B, no error is induced in the staff reading at B. But there will be an error e in the staff reading at A.

The following two figures show the process of reciprocal levelling with observations.

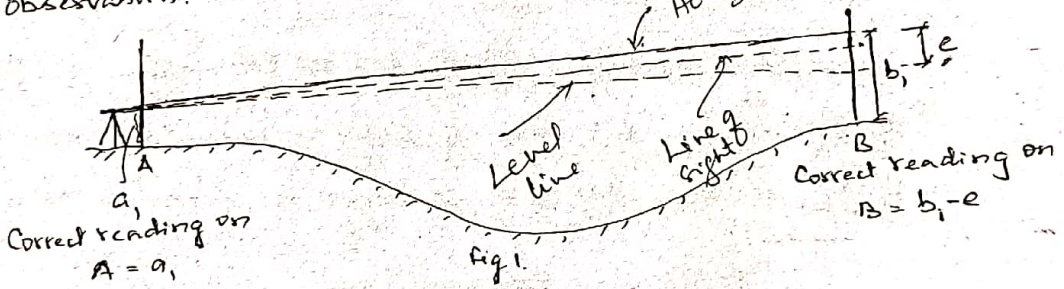


fig 1.

Fig 2

In fig 1,

True difference in elevation = $h = a_1 - (b_1 - e)$ — eqn (1)

In fig 2,

True difference in elevation = $h = (a_2 - e) - b_2$ — eqn (2)

Eqn (1) + Eqn (2)

$2h = a_1 - b_1 + e + a_2 - e - b_2$

$\therefore 2h = (a_1 - b_1) + (a_2 - b_2)$

or $\boxed{h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}}$ (Error e being eliminated)

Note: If h is +, there is "rise" from A to B
and if h is −, there is "Fall" from A to B.

Eqn (1) − Eqn (2)

$0 = a_1 - b_1 + e - a_2 + e + b_2$

$0 = (a_1 - b_1) + 2e - (a_2 - b_2)$

$-\{(a_1 - b_1) - (a_2 - b_2)\} = 2e$

$\therefore \boxed{e = -\left\{\frac{(a_1 - b_1) - (a_2 - b_2)}{2}\right\}}$ (Equation giving magnitude of error)

Let e_L - be the error in collimation and

e_{CR} - be the error due to "curvature and refraction"

(where $e_{CR} = 0.0673 D^2$; e_{CR} is in m & D is in km)

$\therefore \boxed{e = e_L + e_{CR}}$ -

From this equation the e_L due to collimation is obtained.

If e_L is +, the line of sight is inclined upwards and
if e_L is −, the line of sight is inclined downwards.

Examples:

1) The following notes refer to reciprocal levelling taken with one level.

Inst at	staff reading on A	B	Remarks
A	1.824	2.748	Distance AB = 1010 m
B	0.928	1.606	RL of A = 126.386 m.

Find a) RL of B
b) Combined correction for curvature and refraction
c) Angular error in the collimation adjustment of instrument.

Soln: Inst. at A : $a_1 = 1.824$ m ; $b_1 = 2.748$ m $\therefore (a_1 - b_1) = -0.924$ m.

Inst at B : $a_2 = 0.928$ m ; $b_2 = 1.606$ m $\therefore (a_2 - b_2) = -0.678$ m.

{The difference in elevation between A and B} $= h = \frac{(a_1-b_1)+(a_2-b_2)}{2} = \frac{-0.924+(-0.678)}{2} = -0.801$ m

(Negative sign indicates "Fall" from A to B)

$\therefore$ RL of B = RL of A + h = 126.386 + (−0.801) = 125.585 m Ans.

Combined correction for "curvature and refraction"

$e_{CR} = C_{CR} = 0.0673 D^2 = 0.0673 \left(\frac{1010}{1000}\right)^2 = 0.069$ m Ans.

Error in collimation:

$e = e_L + e_{CR}$ where $e = -\left\{\frac{(a_1-b_1)-(a_2-b_2)}{2}\right\}$

$= -\left\{\frac{(-0.924)-(-0.678)}{2}\right\} = +0.123$ m.

$\therefore 0.123 = e_L + 0.069$

$\therefore e_L = +0.054$ m

Since +ve, line of sight is inclined upwards

Angular error = ~~tan~~ $\alpha = \tan^{-1}\left\{\frac{e_L}{D}\right\}$

$= \tan^{-1}\left\{\frac{0.054}{1010}\right\} = 11''$ Ans.

2. The following records refer to an operation involving reciprocal leveling

Instr at	Staff reading on P	Staff reading on Q	Remarks
P	1.725 m	1.370 m	Dist = PQ = 1200 m
Q	1.560 m	1.235 m	RL of P = ~~1500~~ 100.000 m.

Find i) RL of Q. ii) e_{CR} iii) α.

Soln: Instr. at P; $P_1 = 1.725$; $Q_1 = 1.370$ m $\therefore (P_1 - Q_1) = (1.725 - 1.370) = 0.355$ m.

Instr at Q; $P_2 = 1.560$; $Q_2 = 1.235$ $\therefore (P_2 - Q_2) = (1.560 - 1.235) = 0.325$ m

$\therefore h = \frac{(P_1-Q_1)+(P_2-Q_2)}{2} = \frac{(0.355)+(0.325)}{2} = +0.34$ m (Rise from P to Q)

$\therefore$ RL of Q = RL of P + h = 100.000 + 0.340 = 100.340 m. Ans.

$e_{CR} = 0.0673 D^2 = 0.0673 \left(\frac{1200}{1000}\right)^2 = 0.097$ m Ans.

$e = e_L + e_{CR}$ where $e = -\left\{\frac{(P_1-Q_1)-(P_2-Q_2)}{2}\right\} = -\left\{\frac{(0.355)-(0.325)}{2}\right\}$

$= -0.015$ m.

$\therefore -0.015 = e_L + 0.097$ $\therefore e_L = -0.112$ m.

Since −ve, line of sight is inclined downwards

Angular error = $\alpha = \tan^{-1}\left\{\frac{e_L}{D}\right\} = \tan^{-1}\left\{\frac{0.112}{-1200}\right\} = 19.25''$ Ans.

3) The following reciprocal levels were taken with one level on two points A and B, 1645 m apart.

Level near.	Staff reading on A	Staff reading on B
A	2.165 m	3.810 m
B	0.910 m	2.355 m.

Calculate i) the true difference in elevation between A and B
ii) the error due to refraction, when the collimation error is −0.003 m per 100 m.

Soln: $a_1 = 2.165$ m ; $b_1 = 3.810$ m ; $(a_1 - b_1) = (2.165 - 3.810) = -1.645$ m.

$a_2 = 0.910$ m ; $b_2 = 2.355$ m ; $(a_2 - b_2) = (0.910 - 2.355) = -1.445$ m.

$\therefore$ True difference in elevation $= h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2} = \frac{-1.645 + (-1.445)}{2} = -1.545$ m. Ans.

(-ve sign indicates fall from A to B)

Total Error = collimation error + (curvature error − Refraction error)

$$e = e_L + (e_c - e_R) \quad - (1)$$

$$e = -\left\{\frac{(a_1 - b_1) - (a_2 - b_2)}{2}\right\} = -\left\{\frac{-1.645 - (-1.445)}{2}\right\} = +0.100 \text{ m.}$$

$$e_L = -\left(\frac{0.003}{100}\right) \times 1645 = -0.049 \text{ m}$$

$$e_c = 0.0785\, D^2 = 0.0785 \left(\frac{1645}{1000}\right)^2 = 0.212 \text{ m.}$$

Substituting the above values in eqn (1)

$$+0.100 = -0.049 + (0.212 - e_R) \qquad \therefore e_R = 0.063 \text{ m} \quad \text{Ans.}$$

4) Two pegs A and B were 750m apart across a wide river. The following readings were taken with one level.

Level at	Staff reading on A	Staff reading on B
A	1.543 m	2.847 m
B	1.422 m	2.622 m.

The error in collimation adjustment of the level was +0.002 m per 100 m. Determine the true difference in level between A & B and refraction error.

Soln: $h = \frac{(1.543 - 2.847) + (1.422 - 2.622)}{2} = \frac{-1.304 + (-1.200)}{2} = -1.252$ m (Fall from A to B)

$$e = -\left\{\frac{(1.543 - 2.847) - (1.422 - 2.622)}{2}\right\} = -\left\{\frac{-1.304 - (-1.200)}{2}\right\} = +0.052 \text{ m}$$

$e_L = \frac{+0.002}{100} \times 750 = +0.015$ m ; $e_c = 0.0785 \times \left(\frac{750}{1000}\right)^2 = 0.044$ m

$\therefore +0.052 = +0.015 + (0.044 - e_R) \qquad \therefore e_R = 0.007$ m Ans.

5) 06CV34 June/July 2011 (10 marks)

Reciprocal levelling was done to determine the difference in elevation between two stations C and D. The following observations were made. Find the difference in elevation and the error due to line of collimation. Neglect other errors.

Position of Dumpy level	Staff reading on C	Staff reading on D
C	3.250	2.730
D	2.505	1.950

Solⁿ: $C_1 = 3.250$; $d_1 = 2.730$; $(C_1 - d_1) = (3.250 - 2.730) = 0.52$ m

$C_2 = 2.505$; $d_2 = 1.950$; $(C_2 - d_2) = (2.505 - 1.950) = 0.555$ m

$\therefore h_0 = \frac{0.52 + 0.555}{2} = +0.5375$ m (Rise from C to D)

$e = -\left\{\frac{0.520 - (0.555)}{2}\right\} = +0.0175$ m.

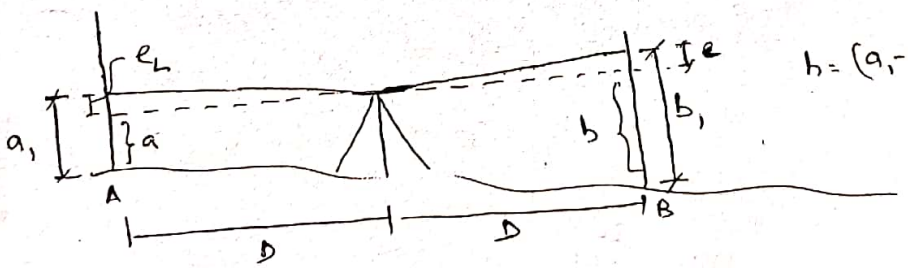
Since other errors are neglected $e = e_L$ $\therefore e_L = +0.0175$ m

$\therefore$ The line of sight is inclined upwards.

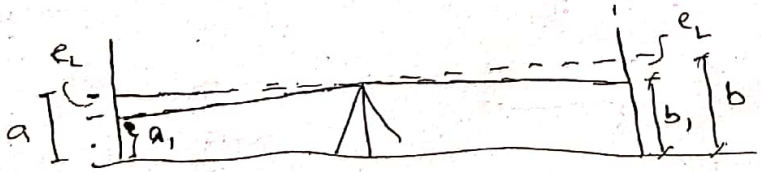
Balancing or Equalising Back sight and Fore sight distances:

The essential condition in levelling is that the line of collimation should be horizontal when staff readings are being taken. The line of sight is horizontal when the bubble is in the centre of its run only if the line of collimation and the bubble axis are exactly parallel.

To eliminate the error due to non-parallelism of line of collimation and bubble axis, it is necessary to keep the lengths of back sight and fore sight equal for accurate work. (Ref. following figs)



$h = (a_1 - e) - (b_1 - e) = (a - b)$



$h = (a_1 + e) - (b_1 + e) = (a - b)$

The following readings have been taken from a page of an old level book. It is required to reconstruct the page. Fill up the missing quantities & apply the usual checks.

Station	B.S	I.S	F.S	Rise	Fall	RL	Remarks
1	3.125					?124.180	B.M
2	2.?65		1.?00	1.325		125.505	T.P.
3		2.320			0.055	125.?450	
4		1.?30		0.400		125.850	
5	1.?40		2.655		0.735	125.?115	T.P.
6	1.620		3.205		2.165	122.?95	TP
7		3.625			2.005	120.?941	
8			? 1.480	2.145		123.090	T.BM.
	$\Sigma BS = 8.05$		$\Sigma FS = 9.14$	$\Sigma Rise = 3.87$	$\Sigma Fall = 4.96$		

→ H.I = RL of Previous point + B.S.

RL of Previous point = H.I - I.S / F.S

① Rise b/w ① & ② points = B.S - F.S

$1.325 = 3.125 - FS$

$FS = 3.125 - 1.325$

$FS = 1.8$

② RL of point ② = 125.505

Rise from ① to ② = 1.325

Hence RL of point ① = 125.505 - 1.325

= 124.18 m

③ Fall from ③ to ③ = 0.055

I.S on point 3 = 2.320

Hence B.S on point = FS = -Fall

$BS - 2.320 = -0.055$

$BS = 2.320 - 0.055$

$BS = 2.265$ m

④ RL of point ③ = RL of point ② - Fall

= 125.505 - ~~0.055~~ 0.055

RL of Point 4 = 125.850

Rise from 3 to 4 = 125.850 - 125.450 = 0.400

Now I.S on point 3 = 2.320

Rise I.S Point 4 = 2.320 - 0.400 (2.320 - IS = 0.400)

IS = 1.920

Fall from 4 to 5 = 1.920 - 2.055 = -0.735 (Fall)

Hence RL of point 5 = 125.85 - 0.735 = 125.115

F.S of point 6 = 3.205

Fall from point 5 to 6 = 2.165

BS = 3.205 = -2.165

BS = ~~2.165~~ 3.205 - 2.165

BS = 1.04

RL of Point 6 = RL of point 5 - 2.165

= 125.115 - 2.165

= 122.95

RL of point 6 = ~~1.620~~ Back sight = 1.620

IS of Point 7 = 3.625

Fall from 6 to 7 = 1.620 - 3.625

= -2.005

RL of Point 7 = RL of 6 - Fall

= 122.950 - 2.005

= 120.945

RL of point 8 = 123.090

Rise from 7 to 8 = 123.090 - 120.945

= 2.145

Hence F.S of point 8 = 3.625 - 2.145

= 1.480

Checks

$\Sigma BS - \Sigma FS$ = Last RL - first RL = Σ Rise - Σ Fall

8.05 - 9.4 = 123.090 - 124.180 = 3.67 - 4.96

-1.09 = -1.09 = -1.09