

-		_		-	-	
-	•		ъ.	n		в.
	n.		_	9		ш

17

What's New in This Edition? 18 Acknowledgments 18

1 • INTRODUCTION

Problems 40 Bibliography 41 21

1.1	Definition of Surveying 21	
1.2	Geomatics 23	
1.3	History of Surveying 24	
1.4	Geodetic and Plane Surveys 29	
1.5	Importance of Surveying 30	
1.6	Specialized Types of Surveys 31	
1.7	Surveying Safety 33	
1.8	Land and Geographic Information Systems 34	
1.9	Federal Surveying and Mapping Agencies 35	
1.10	The Surveying Profession 36	
1.11	Professional Surveying Organizations 37	
1.12	Surveying on the Internet 38	
1.13	Future Challenges in Surveying 39	

65

2 • UNITS, SIGNIFICANT FIGURES, AND FIELD NOTES

PART I UNITS AND SIGNIFICANT FIGURES 43

- 2.1 Introduction 43
- 2.2 Units of Measurement 43
- 2.3 International System of Units (SI) 45
- 2.4 Significant Figures 47
- 2.5 Rounding Off Numbers 49

PART II FIELD NOTES 50

- 2.6 Field Notes 50
- 2.7 General Requirements of Handwritten Field Notes 51
- 2.8 Types of Field Books 52
- 2.9 Kinds of Notes 53
- 2.10 Arrangements of Notes 53
- 2.11 Suggestions for Recording Notes 55
- 2.12 Introduction to Data Collectors 56
- 2.13 Transfer of Files from Data Collectors 59
- 2.14 Digital Data File Management 61
- 2.15 Advantages and Disadvantages of Data Collectors 62

Problems 63 Bibliography 64

3 • THEORY OF ERRORS IN OBSERVATIONS

- 3.1 Introduction 65
- 3.2 Direct and Indirect Observations 65
- 3.3 Errors in Measurements 66
- 3.4 Mistakes 66
- 3.5 Sources of Errors in Making Observations 67
- 3.6 Types of Errors 67
- 3.7 Precision and Accuracy 68
- 3.8 Eliminating Mistakes and Systematic Errors 69
- 3.9 Probability 69
- 3.10 Most Probable Value 70
- 3.11 Residuals 71
- 3.12 Occurrence of Random Errors 71
- 3.13 General Laws of Probability 753.14 Measures of Precision 75
- 3.15 Interpretation of Standard Deviation 78
- 3.16 The 50, 90, and 95 Percent Errors 78
- 3.17 Error Propagation 80
- 3.18 Applications 85
- 3.19 Conditional Adjustment of Observations 85
- 3.20 Weights of Observations 863.21 Least-Squares Adjustment 87

3.22 Using Software 88 Problems 89 Bibliography 91

4 • LEVELING-THEORY, METHODS, AND EQUIPMENT

93

LEVELING-THEORY AND METHODS 93

- Introduction 93
- 4.2 Definitions 93
- 4.3 North American Vertical Datum 95
- 4.4 Curvature and Refraction 96
- 4.5 Methods for Determining Differences in Elevation 98

EQUIPMENT FOR DIFFERENTIAL LEVELING PART II

- Categories of Levels 105
- 4.7 Telescopes 106
- 4.8 Level Vials 107
- 4.9 Tilting Levels 109
- 4.10 Automatic Levels 110
- 4.11 Digital Levels 111
- 4.12 Tripods 113
- 4.13 Hand Level 113
- 4.14 Level Rods 114
- 4.15 Testing and Adjusting Levels 116

Problems 120

Bibliography 122

5 • LEVELING—FIELD PROCEDURES AND COMPUTATIONS

- 5.1 Introduction 123
- 5.2 Carrying and Setting Up a Level 123
- 5.3 Duties of a Rodperson 125
- 5.4 Differential Leveling 126
- 5.5 Precision 132
- 5.6 Adjustments of Simple Level Circuits 133
- 5.7 Reciprocal Leveling 134
- 5.8 Three-Wire Leveling 135
- 5.9 Profile Leveling 137
- Grid, Cross-Section, or Borrow-Pit Leveling 141 5.10
- 5.11 Use of the Hand Level 142
- 5.12 Sources of Error in Leveling 142
- 5.13 Mistakes 144
- 5.14 Reducing Errors and Eliminating Mistakes 145
- 5.15 Using Software 145
- Problems 147

Bibliography 149

6 • DISTANCE MEASUREMENT

PART I METHODS FOR MEASURING DISTANCES 151

- 6.1 Introduction 151
- 6.2 Summary of Methods for Making Linear Measurements 15
- 6.3 Pacing 152
- 6.4 Odometer Readings 152
- 6.5 Optical Rangefinders 153
- 6.6 Tacheometry 153
- 6.7 Subtense Bar 153

PART II DISTANCE MEASUREMENTS BY TAPING 153

- 6.8 Introduction to Taping 153
- 6.9 Taping Equipment and Accessories 154
- 6.10 Care of Taping Equipment 155
- 6.11 Taping on Level Ground 156
- 6.12 Horizontal Measurements on Sloping Ground 158
- 6.13 Slope Measurements 160
- 6.14 Sources of Error in Taping 161
- 6.15 Tape Problems 165
- 6.16 Combined Corrections in a Taping Problem 167

PART III ELECTRONIC DISTANCE MEASUREMENT 168

- 6.17 Introduction 168
- 6.18 Propagation of Electromagnetic Energy 169
- 6.19 Principles of Electronic Distance Measurement 172
- 6.20 Electro-Optical Instruments 173
- 6.21 Total Station Instruments 176
- 6.22 EDM Instruments Without Reflectors 177
- 6.23 Computing Horizontal Lengths from Slope Distances 178
- 6.24 Errors in Electronic Distance Measurement 180
- 6.25 Using Software 185

Problems 185

Bibliography 188

7 • ANGLES, AZIMUTHS, AND BEARINGS

189

- 7.1 Introduction 189
 - 7.2 Units of Angle Measurement 189
 - 7.3 Kinds of Horizontal Angles 190
 - 7.4 Direction of a Line 191
- 7.5 Azimuths 192
- 7.6 Bearings 193
- 7.7 Comparison of Azimuths and Bearings 194
- 7.8 Computing Azimuths 195
- 7.9 Computing Bearings 197

7.1	1 Magnetic Declination 200	
7.1 7.1 7.1		
	6 Mistakes 207 ems 207	
Biblio	ography 209	
8 • TO	GLE OBSERVATIONS 2	11
PART I	TOTAL STATION INSTRUMENTS 211	
8. 8. 8. 8.	Characteristics of Total Station Instruments 211 Functions Performed by Total Station Instruments 214 Parts of a Total Station Instrument 215 Handling and Setting Up a Total Station Instrument 219	
PART II	ANGLE OBSERVATIONS 223	
8. 8. 8.1 8.1 8.1 8.1 8.1	Observing Horizontal Angles with Total Station Instruments 224 Observing Horizontal Angles by the Direction Method 226 Closing the Horizon 227 Observing Deflection Angles 229 Observing Azimuths 231 Observing Vertical Angles 231 Sights and Marks 233 Prolonging a Straight Line 234	
8.1 8.1 8.1 8.2	7 Random Traverse 237 8 Total Stations for Determining Elevation Differences 238 9 Adjustment of Total Station Instruments and Their Accessories 239	
8.2 8.2 Prob	1 Propagation of Random Errors in Angle Observations 248	
	The second secon	
O a TD	AVEDSING	51

Introduction 251 9.1

Observation of Traverse Angles or Directions 253
Observation of Traverse Lengths 254